ELECTRICAL REVIEW

THE PIONEER ELECTRICAL WEEKLY OF AMERICA

VOL. XLIV. No. 3. NEW YORK, SATURDAY, JANUARY 16, 1904. ISSUED WEEKLY

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PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
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EUROPEAN OFFICE: 42 Old Broad Street, London, E. C. . . HENRY W. HALL, Manager

TELEPHONE "21 Cortlandt." Private exchange to all Departments.
REGISTERED CABLE ADDRESS: "Electview," New York.

SUBSCRIPTIONS

One Year, United States and Canada $3.00
One Year, Foreign Countries 5.00
Single Copies, each 10
Copies supplied for only one year back, each 25

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CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than *Monday noon* to assure publication in that week's issue.

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WANTED—A GOOD IGNITER.

It not infrequently happens that, in any new development, some minor detail gives more trouble than all the rest of the apparatus. In this respect, automobiles are notably weak in two points. Tire troubles are probably responsible for the greatest number of breakdowns, and the tire itself requires constant watching and care. The other weak point is the apparent lack of an entirely reliable igniter. At the recent motor car trials, held in London, England, in September, under the auspices of the Automobile Club of Great Britain and Ireland, no fewer than forty-one per cent of the cars that stopped did so on account of trouble with ignition.

THE POSSIBILITIES OF AN ALTERNATING-CURRENT RAILWAY SYSTEM.

Until the single-phase alternating-current motor was seriously proposed, discussions on electric railway operation dealt with roads intended for passenger traffic only, where the conditions approximated the problem presented by a large city. There were many passengers to be hauled; numerous stops to be made, and a fast schedule of many trains was to be maintained. These are the conditions under which the direct-current motor has been most successful, because traffic must be heavy in order to pay dividends on an expensive installation. There have, it is true, been a number of interurban lines which differ considerably in their method of operation from city traction systems; but in all cases a number of important points, between which there is a good deal of travel, are connected together. A notable change in conditions has been brought about by the development of the alternating-current motor, due primarily to the fact that it makes feasible the operation of long lines from a single central station. In the alternating system, the substations become merely transformer houses, and current can be collected from the working conductor at a voltage four or five times as high as that now in use for direct-current motors, thus reducing enormously the amount of copper required for the line.

Alternating-Current System Cheaper than the Direct-Current System.

This advantage of the alternating system, as compared with the direct-current system, was brought out in a paper read by Mr. P. M. Lincoln at a recent meeting of the electrical section of the Canadian Society of Civil Engineers, and which appeared in the ELECTRICAL REVIEW for December 19. At the same meeting Mr. A. H. Armstrong discussed the suitability of the alternating-current motor for handling freight, in a valuable paper which is given in full in this issue. Mr. Armstrong assumes, first, certain classes of service, and computes the cost of operation by steam. He then computes the cost of installing electrical systems which could handle the traffic, and endeavors to show that the saving effected in operation by the latter, as compared with steam, would, in nearly all cases, pay a satisfactory rate of interest on the cost of the electrical equipment, besides bringing the advantages which go with electrical operation.

Alternating-Current System Compared with Steam.

To make the discussion fairly general, trains varying in weight from 250 to 2,000 tons are considered, and schedules of five, ten and twenty trains each way per day are assumed. The electrical system gains, first, in the fuel consumption. In a central station the most economical generating plant may be installed and a high efficiency may be attained in a high-tension distributing system. The electric locomotive gains also in the

labor account; as a crew working ten hours a day will be in actual service on a steam road not more than forty or fifty per cent of the time. With electricity eighty-three per cent of the time will be spent in actual service. Other items of supplies and repairs are considered, and curves plotted for both the steam and electric systems. A comparison of the two curve sheets shows that operation by the alternating-current system is more economical in all cases, except for trains of 2,000 tons at high speeds; the advantage of operating electrically being the more marked the greater the cost of fuel.

The Saving Effected by Electrical Operation.

The gain from electrical operation is greater for light than for heavy trains. It increases with the number of trains moved per day, but decreases with increase in speed. Thus, with coal at $2 per ton, and with twenty trains of 250 tons, running at an average speed of ten miles an hour, the saving would amount to interest of 34.5 per cent upon the electrical investment. For ten trains a day it would be 18.3 per cent, and for five trains a little more than nine per cent. For 2,000-ton trains the corresponding figures are 8.9 per cent, 8.48 per cent and 5.75 per cent. At high speeds the saving effected by the electrical equipment is less; but, as stated above, except for very heavy trains, running at more than twenty miles an hour, the electrical system is the cheaper to operate.

Electrical Operation Feasible.

From these figures it would seem that it is not only possible to-day to move both the passenger and freight traffic of practically all our steam roads; but, what is more important, the replacing of the steam locomotive by the electric would, at least on a large number of roads, pay a handsome profit on the cost of the electrical apparatus. The conditions assumed for the electrical installation are quite conservative, and it is very probable that, should the work be undertaken, higher voltages and longer distances of transmission from the power station than those contemplated in the paper would be adopted. This would enable the electrical system to make a better showing than that given in Mr. Armstrong's paper, and would considerably reduce, if not reverse, the advantage of steam locomotives for hauling the heaviest trains at high speeds, and also would probably make profitable its use on roads where there are not more than five trains per day. While, under the conditions assumed, electrical operation of such roads is cheaper than steam, the interest on the investment is found to be not more than four to seven per cent, which would hardly pay. The electrical system would, of course, bring other advantages, such as making practicable the distributing of the locomotives throughout the train, and doing away with tenders, turn-tables and other accessory appliances necessary in steam operation. Mr. Armstrong has made a strong argument for the alternating-current traction system as applied to steam railroads, and it is probable that the present year will be noteworthy for the development made in this direction.

GAS PIPES IN CITIES.

Severe touches of winter, such as that of the past week, cause disturbances in nearly all public utilities, but the difficulties encountered by any one are not sufficient for its wholesale condemnation by those interested in competing industries; though competing companies would be foolish not to learn what they can from the troubles of their rivals. During the past winters, before wires were put underground, the electrical utilities had their full share of trouble, and they were forced to better, though more expensive, methods of distribution, in large cities, with the result that they are now comparatively independent of the weather. On the other hand, the intense cold interfered, to a considerable extent, with the distribution of gas for light and heat.

Injury to Pavement.

There is another objection to the use of gas in cities, and which seems to indicate that the gas-distributing systems are not as well constructed as they should be. It seems to be impossible, with the present system of laying pipes, to prevent leaks in gas mains; and when this occurs in the streets, to get at the pipes the pavement must be torn up, not only with an annoying interference to traffic, but with much injury to the pavement, as the patch made when the paving is relaid never seems to be as good as the original.

Danger of Explosions from Leaks.

There is, too, a danger in the use of gas, though how serious this is it is impossible to say, as it has only recently been recognized. An examination last summer of the air in a large number of theatres in New York showed, in certain cases, that gas had accumulated to the amount of one-half of one per cent to two per cent of the air, and this occurred when all the ventilation that could be obtained was sought. An explosive mixture is reached when from between six and seven per cent of gas is found in the air; and if, during the summer, it was possible for gas to collect in places to the extent of two per cent of the air, it does not seem impossible that a similar leak into a house during the winter, when all but a few outlets are closed, might reach an explosive concentration. Is it not possible that certain mysterious fires may have been due to this cause? A lantern used in a search for the leak or a burning match thrown carelessly into a corner would be sufficient to cause an explosion or start a fire under such conditions.

The Proper Field for Gas.

How long will it be before the gas companies are forced to better methods of distributing their product, and how long will it be before the use of gas is restricted to its proper place—that is, for heating and cooking? The electric light, if installed according to the rules of the fire underwriters, is, without doubt, the safest of all artificial illuminants; but it is out of the question, at the present time at least, to use electricity largely for heating and cooking. This is the field that the gas companies should make their own. But those interested should see that all possible precautions against leakage are taken, and that the system be made as safe as it can be.

LIGHTNING ARRESTERS.

There are several problems which confront the electrical engineer to-day, and which as yet seem far from being settled satisfactorily to all concerned. One of these, it need hardly be said, is that of electrolysis of buried metallic structures, caused by stray currents. Opinions differ widely, not only as to the amount of destruction which is going on to-day, but also as to the proper method of diminishing or preventing it, one side advocating a construction which would make the buried metals as perfect electrical conductors as possible, and the other side going to the other extreme and advocating breaking the structure into sections, so as to make it a path of high resistance for the current. Over the question of protection against lightning, opinions differ just as widely, but this problem presents a different aspect, in that an engineer is concerned in protecting his own machinery against lightning, while, in general, it is the apparatus of some other company which is liable to injury from electrolysis.

Protection Against Lightning Not Always Thought Necessary.

Methods of protecting against lightning or atmospheric discharges vary from those making use of elaborate apparatus, often installed at many points along the line, to those in which no such devices are employed. The practice adopted for any particular installation is, of course, dependent upon local conditions, as well as upon the belief of the engineer in the efficacy of such devices. In some installations the location of the circuits may be such that there seems to be no need of protection, and where the use of lightning arresters would not only call for an apparently unnecessary expense, but they might become a decided nuisance. On the other hand, lines carried over high ground are particularly exposed to such atmospheric disturbances, and some method of preventing damage to the station equipment is essential.

Methods of Protection Against Lightning.

Many means have been proposed for preventing lightning or other atmospheric disturbances from reaching the electrical machinery. In the earlier types of lightning arrester used on telegraph and telephone lines, a small air-gap, connected to a grounded circuit, was provided, which offered an impassable gap to the line voltage, but which could be jumped by the high pressure of the atmospheric disturbance. While the actual amount of protection afforded to the apparatus by this means may be questioned, there was no disastrous secondary effect such as was found to take place when the device was adopted in an enlarged form for protecting light and power circuits. In these cases, once the air-gap had been bridged by a spark, an arc may be formed by the line voltage, which must be broken. This has been accomplished by causing the line current, in passing through the grounded circuit, to excite an electromagnet, which opens a switch; or the expansion of the air heated by the arc may be made to accomplish the same purpose. Such mechanisms are usually automatic and reset themselves.

Non-Arcing Arresters.

In the types of arrester just mentioned the line voltage was allowed to form an arc, and the passage of the current to the ground was made to open the switch. Another type of arrester prevented the arc being formed by using certain alloys as terminals for the spark-gap. In this type the discharge to the ground of the atmospheric charges across small air-gaps does not leave a conducting column of vapor, and consequently the line voltage does not establish an arc. A third type of arrester consists merely of providing a high-resistance path between the line and the ground. As the quantity of electricity involved in a lightning discharge is small, this high resistance provides an ample path. On the other hand, there is a continual leakage of current from the line to the ground; but this may be made small.

Use of Kicking Coils.

In using any apparatus of the types described, the path of least resistance to the lightning must be across the arrester and not through the machine. This is accomplished by adding in the line, between the arrester and the machine to be protected, an inductance or kicking coil, which, due to the high frequency of the lightning discharge, offers a high impedance to it, while imposing but a small impedance to the line current. However, a high inductance is always present in the electrical apparatus itself, and, in many cases, this is relied upon to turn aside the discharge, no kicking coil being thought necessary.

Series Arresters.

The types of apparatus thus far considered may be classed as those which provide a circuit to the ground, in shunt with the station. There is a type which is connected in series with the line, but which forces the discharge to take a shunt path. In this, a path of high conductivity is provided for the line current; but, by furnishing suitable discharge gaps, and by the use of a magnetic field, the atmospheric charge is thrown out without causing the formation of an arc. In another ingenious system, the line is kept discharged of atmospheric charges by means of water allowed to drip on the conductors. The latter device is extremely simple, but it has been used, it is said, with much success.

The Utility of Lightning Arresters.

The results obtained by the use of these differing types of apparatus are as varied as the types themselves. Some engineers report complete immunity from damage due to atmospheric discharges; others are but little affected, and others, again, hold that there is no sure method of preventing damage. However, data are accumulating and experience is teaching, and every year we learn a little more about the nature of atmospheric electricity and make some progress toward the definite solution of this troublesome problem.

MEASUREMENT OF SMALL RESISTANCES.

We call attention to the series of articles which ends in this issue of the ELECTRICAL REVIEW, entitled "Accurate Measurement of Small Resistances with the Kelvin Double Bridge." This appeared first in the *Zeitschrift für Instrumentenkunde,* and is a communication by Herren W. Jaeger, S. Lindeck and H. Diesselhorst to the Physico-Technical Reichsanstalt. It has been translated and slightly abridged by Dr. Morton G. Lloyd. This serial gives, we believe, the most satisfactory and complete discussion of this valuable method of measuring small resistances that has yet been published.

THE ACCURATE MEASUREMENT OF SMALL RESISTANCES WITH THE KELVIN DOUBLE BRIDGE—IV.[1]

(Concluded.)

BY W. JAEGER, S. LINDECK AND H. DIESSELHORST.

COMPARISON OF TWO COILS IN THE RATIO 1 : 10 (0.00001 OHM WITH 0.0001 OHM).

Comparisons in ratio 1 : 10 occur principally in the determinations of the standards, and since the ratio coils can not be interchanged, they require very accurate knowledge of a, b α and β.

The present example involves the smallest resistance which has as yet been accurately measured in the Reichsanstalt. This resistance (0.00001 ohm No. 712) is made of cast[2] manganin, and is intended for use in the measurement of heavy currents.[3] Its adjustment is only approximate, as the manufacturer (O. Wolff, Berlin) did not at that time have the apparatus necessary for the adjustment of such a small resistance.

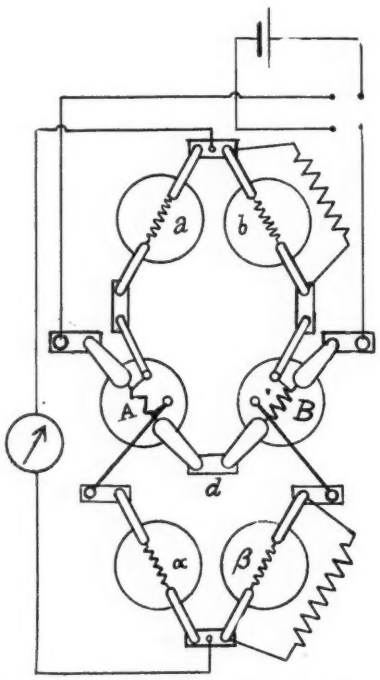


FIG. 5.—ARRANGEMENT OF CONNECTION OF KELVIN DOUBLE BRIDGE IN COMPARISON OF TWO COILS IN THE RATIO 1 : 10.

Fig. 5 shows the connections. Resistances a and α are each ten ohms; b and β, each 100 ohms. b and β are each shunted by a box of precision resistances. The connecting resistances, which form part of the ratio arms (the potential leads of the coils being compared, together with the cables completing the connections) were determined by galvanometer deflections, as was also d. The values to be included in a, b, α, β were respectively 523, 621, 321, 403 microhms. d was eighty microhms, or eighty times as large as the resistance being determined, so that an error in the auxiliary arms would greatly influence the result. Since the small resistance is adjusted to only about one per cent, shunts of 10,000 ohms each from the resistance boxes must be applied to b and β, and interpolation is accomplished by changing both shunts to 20,000 ohms.

A du Bois-Rubens shielded galvanometer of fifty ohms' resistance (two coils of 100 ohms in parallel) was used, with scale three metres distant. The current was about 150 amperes. The observations follow. They were made by two observers in quick succession.

Current.	Galvanometer reading for shunt of		Temperatures.
	10,000	20,000	
Direct.....	539.9	580.6	A = 18.75
Reversed.....	588.2	547.2	
Difference....	−48.3	+33.4	B = 20.15
Repeated.			a = 20 0
Direct.....	539.2	581.4	
Reversed.....	588 0	547.1	b = 20.0
Difference....	−48.8	+34.3	α = 19.95
Mean.....	−48.55	+38.85	β = 19.9

Taking the temperature coefficients into account, and including the connecting resistances, we have

for shunt 10,000 ohms,

$$\frac{a}{b} = 0.1010143, \text{ defective} = -48.55.$$

for shunt 20,000 ohms,

$$\frac{a}{b} = 0.1005142, \text{ defective} = -33.85.$$

A difference in $\frac{a}{b}$ of 0.0005001 gives deflection of 82.4.

The value of $\frac{a}{b}$ corresponding to zero deflection is hence

$$\frac{a}{b} = 0.1010143 - \frac{48.55}{82.4}\ 0.000501 = 0.1007196.$$

The correction is again very small, as $\frac{\alpha}{\beta}$ is nearly equal to $\frac{a}{b}$.

$$k = \frac{0.000080}{0.0001} \cdot \frac{1}{1+0.101}$$

$$(0.1010133 - 0.1010143) = -0.0000007$$

and $$\frac{A}{B} = 0.1007203.$$

III—ANOTHER METHOD OF CONSIDERING THE CORRECTION TERM.

In the two examples given, the correction term k has been calculated, which required a knowledge of all the quantities appearing in it. There is yet another method, which also requires an auxiliary observation, but which obviates the measurement of d, provided the ratios $\frac{a}{b}$ and $\frac{\alpha}{\beta}$ are known.

The principal measurement is made in exactly the same way as described in the above example; that is, the galvanometer deflection is observed, and then the change of deflection for a given simultaneous change in both main and auxiliary ratios. The auxiliary measurement consists in repeating the reading while only the auxiliary ratio $\frac{\alpha}{\beta}$ is changed by a definite amount E, say, 0.1 per cent. The change in the galvanometer deflection is proportional to E. It is then easy to calculate what change would have been made in the deflection for the principal measurement, if $\frac{\alpha}{\beta}$ had been exactly equal to $\frac{a}{b}$. Making this correction to the original deflection takes account of the correction term, and the further calculations are made just the same as for the ordinary Wheatstone bridge. This method leads to the same result, within the limits of accuracy of the observations, as those used in the above examples, as shown by repeated checks.

The small change in the auxiliary ratio and the observation of the corresponding change in the galvanometer deflection are also valuable in getting one's bearings before beginning a measurement. For instance, in comparing two resistances of value 0.1 ohm it will be found that, in spite of great sensibility of the apparatus, a change of 0.1 per cent in $\frac{\alpha}{\beta}$ alone will not produce a noticeable effect on the galvanometer. The work can consequently be simplified by leaving the auxiliary ratio coil U (Fig. 4) always set upon contact 2 and always in the one position (not reversed), as the inequality in the two sides, including connections, will always be less than 0.1 per cent. On the other hand, it will be found in measuring very small resistances, that a change of 0.1 per cent in the auxiliary ratio arms will produce a much larger deflection than the simultaneous change of both main and auxiliary ratio by 0.1 per cent. In this case more weight is to be laid on an accurate knowledge of the difference $\left[\frac{\alpha}{\beta}\right] - \left[\frac{a}{b}\right]$ in the correction term than upon the determination of the ratio $\frac{a}{b}$ in the principal measurement.

[1] Communication from the *Physicc-Technical Reichsanstalt.* Abridged translation from *Zeitschrift für Instrumentenkunde*, by Morton Githens Lloyd, Ph.D.

[2] Cast manganin is no longer used by O. Wolff, as sheet manganin is much easier to adjust.

[3] A description of this resistance is given by K. Feussner, *Elektrotechnische Zeitschrift*, xvi, p. 361 (1895.)

IV—COMPARISON OF THE TWO SETS WITH EACH OTHER AND WITH PREVIOUS MEASUREMENTS.

The results of the two sets of observations are shown in table 2.

TABLE II.

Resistance.	Division I.	Division II.	Difference in millionths.
$[0.1]_A$	0.0999610	0.0999609	+1
$[0.1]_B$	0.1000004	0.1000007	−3
$[0.01]_A$	0.01000215	0.01000208	+6
$[0.01]_B$	0.00999999_5	0.00999993	+6.5
$[0.001]_A$	0.000999653	0.000999654_5	−1.5
$[0.001]_B$	0.000999718	0.000999720_5	−2.5
$[0.0001]_C$	0.0001000233	0.0001000216	+17
No. 700	0.0001000107	0.0001000082	+25

All results are reduced to eighteen degrees centigrade. Each value given has been adjusted to the most probable value from a comparison with another resistance of the same magnitude and a comparison of each of these with a resistance ten times as great.

The good agreement of these two sets of entirely independent observations shows that the values of resistances even as small as 100 microhms can be derived from the one-ohm standard with an accuracy far exceeding commercial requirements. The larger differences for 0.0001 ohm is due to the low sensibility of the galvanometer used in division 1.

The constancy of the manganin resistances may be judged from the values given in table 3 which summarizes the measurements made on the same resistances for a period of years. In each case the values are obtained by stepping down from the one-ohm standard, which is determined by the fundamental mercury standards.

A very satisfactory constancy will be noticed. $[0.1]_B$ has changed most—about 0.01 per cent in seven years—but this was principally in the first year, when it was new. The results for the 0.01 ohm resistances do not extend back as far as the others, because the thin sheet metal (about 0.1 millimetres) first used for these proved to be unsuitable. In two years the resistance increased nearly 0.1 per cent. In October, 1896, these were replaced by sheet manganin ten times as thick, and correspondingly narrower and longer; since then the constancy is good. How much of the improvement is due to decreased sensibility to chemical attack, and how much to greater mechanical rigidity, is left undecided.

It must be remembered that changes of 0.002 to 0.003 per cent in the values given do not necessarily imply changes in the resistances, but may be due to errors of observation in the wider sense. For if an error of 0.001 per cent be made in determining the ratio 1 : 10 for stepping down, this will amount to 0.004 per cent for a resistance of 0.0001 ohm. It is only when a trend in the figures covering a period of years, amounting to more than this value, is noticeable, that a change of resistance is certain.

TABLE III.

EXCESS OF RESISTANCE AT EIGHTEEN PER CENT CENTIGRADE OVER NOMINAL VALUE IN HUNDRED-THOUSANDTHS.

Date.	$[0.1]_A$	$[0.1]_B$	$[0.01]_A$	$[0.01]_B$	$[0.001]_A$	$[0.001]_B$	Date.	$[0.0001]_C$
Oct., 1895	− 39.5	−10.5	.....	.....	− 39	− 35.5	.....	.....
June, 1896 ...	− 38	− 7.5	.....	.....	− 37	− 36	.....	.....
Aug., 1896 ...	− 38.5	− 3	.....	.....	− 32.5	− 29.5	.....	.....
Nov., 1896 ...	.....	.....	+ 26.5	+ 6	.....	.....	April, 1898.	+ 23
June, 1897 ...	− 37.5	0	+ 25	+ 4	− 32.5	− 30.5	July, 1899..	+ 20
Feb., 1898....	− 38.5	− 1	+ 23.5	+ 2.5	− 32.5	− 29	Nov., 1899..	+ 17
March, 1899 ..	− 38	− 1.5	+ 21	− 1	− 36	− 32	July, 1900..	+ 17.5
Feb., 1900....	− 36	+ 0.5	+ 23	+ 1.5	− 33	− 25.5	March, 1901.	+ 22
March, 1901 ..	− 38.5	+ 0.5	+ 23	+ 1	− 32	− 25	Nov., 1901..	+ 20.5
Feb., 1902....	− 39	+ 0.5	+ 21	− 0.5	− 34.5	− 28	March, 1902.	+ 21.5
Feb., 1903....	− 40	+ 1.5	+ 20.5	− 1	− 34	− 28.5	Feb., 1903..	+ 21.5
Change.	None certain.	+ 12	− 6	− 7	+ 5	+ 7	.....	None certain.

V—APPENDIX.

I—SENSIBILITY OF THE KELVIN DOUBLE BRIDGE.

In so far as the sensibility is concerned, we shall neglect the small resistances A and B in comparison with a, b, α and β, and the external circuit. The main current C may also be taken as the current in A and B. Let r be the resistance of the galvanometer arm, and designate the ratio $\frac{B}{A}$ by m, B being assumed the larger. Consider the arms adjusted so that there is no current in the galvanometer. Now let one arm of the bridge be changed by the definite small fraction E of its value, producing a current i in the galvanometer. This shows the sensibility of the apparatus with the galvanometer used, but gives no measure of the attainable accuracy of the Kelvin bridge in general. For in choosing a suitable galavanometer, it depends upon whether it is to be used in a circuit of high or low resistance. In order to define the sensibility of the bridge, we must accordingly state the resistance of the circuit, as well as the value of i.

Since, in a balanced bridge, an electromotive force in the galvanometer arm produces no current in either the connection d or the battery arm, the resistance completing the galvanometer circuit is made up of the two parts $(a + A + \alpha)$ and $(b + B + \beta)$ in parallel. The total resistance of the circuit is

$$R = r + \frac{m}{m+1}(a + \alpha)$$

Let the electromotive force $e = i\,R$, which would produce the current i in the galvanometer circuit, be given instead of i. This is then also the electromotive force which would prevent a current after the change in resistance had been made in one arm. In the unbalanced bridge, this compensating electromotive force would, with the assumptions made above, have the value

$$e = \frac{a\,B - b\,A + \frac{d}{\alpha+\beta}(a\beta - b\alpha)}{a+b}\,C$$

Starting out now from the condition for no deflection, different values for e are obtained, according to whether the change ϵ is made in one of the resistances under comparison, in a main ratio arm, or in one auxiliary ratio arm. If in a main ratio arm, we have

$$e_1 = \pm\frac{1}{m+1}\left(B + \frac{m}{m+1}\,d\right)\epsilon\,C$$

For a change in A or B

$$e_2 = \mp\frac{B}{m+1}\,\epsilon\,C \qquad (7)$$

and for a change in α or β

$$e_3 = \mp\frac{m}{(m+1)_2}\,d\,\epsilon\,C$$

The first value (e_1) is equal and opposite to the sum of the other two. It is thus most advantageous to interpolate on a or b. When A and B are so large that it is possible to use shunts on them, then d is negligible in comparison with B, and interpolating on A or B has the same effect as on a or b. Interpolating simultaneously on main and auxiliary ratios, as in the examples from division 2, gives

the same sensibility as interpolation on A or B.

It is of significance that the expressions for e_1, e_2 and e_3 do not depend upon the values of the ratio arms a, b, α and β. These appear only in the expression for the resistance of the galvanometer circuit. Consequently, in choosing values for the main and auxiliary ratio arms, we can consider e_1, e_2 or e_3 given. Now it is evident that a given electromotive force can be measured more accurately, the smaller the resistance of the circuit. It follows that a galvanometer of low resistance must be used. But for various reasons we can not decrease R below a certain point. In the first place, the main and auxiliary ratio arms can not well be chosen less than one ohm without giving their connecting resistances too great influence. And the type of galvanometer may also set a lower limit for R. With the value of R once fixed, it is immaterial for the sensibility how this is divided—whether it be principally in the ratio arms or an extra resistance inserted in series with the galvanometer. But the former would be chosen in order to cut down the influence of the connecting resistances.

The values of e_1 and e_2 are respectively proportional to BC and $\left(B+\frac{m}{m+1}d\right)C$, that is, to the difference of potential between the ends of the resistance B or between the outer end of B and the junction of α and β But the current which may be used is limited not by the potential, but by the expended energy $C^2 B$. For equally loaded resistances, the suitable potential BC is accordingly equal to a constant multiplied by $\sqrt{B}$. In other words, the maximum sensibility of the method decreases with the resistance, and proportionally to the square root.

For precise measurements a lower limit must of course be set for the current than would be necessary for many other purposes, where the rise of temperature is unimportant. In the examples given, the currents were far below the limits for technical work.

II — AVAILABILITY OF THE DEPREZ-D'ARSONVAL GALVANOMETER FOR THE MEASUREMENT OF SMALL RESISTANCES.

We will first notice some points which are of importance in the use of a moving-coil galvanometer, but which are none too generally recognized. For most measurements it is advantageous to use the instrument in a nearly dead-beat condition. Now it is well known that the sensibility may be made higher the greater the damping permitted. On the other hand, the damping may not be increased beyond the limit of aperiodicity lest the use of the instrument be made impossible on account of the "creeping." With given apparatus—that is, a fixed resistance for the external circuit through the galvanometer, the galvanometer selected should have such an internal resistance as to be aperiodic, in order to attain the highest sensibility.

Aperiodicity has the additional advantage that the time required to come to rest, and, accordingly, the time required to take a reading, are less than for any other amount of damping.[1]

For these reasons the galvanometer should be made aperiodic when, for any purpose, it is to be used with a lower sensibility. This is accomplished most simply by inserting series resistance in the circuit, and at the same time applying an appropriate shunt to the galvanometer, or to the galvanometer with suitable resistance in series.[2]

The best damping, to be sure there is no "creeping," is secured when the first swing goes slightly past the point of rest, for a large deflection.[3]

In order to test the suitableness of the moving-coil galvanometer for the measurement of small resistances, an instrument with the smallest possible resistance must be selected, from considerations stated above. One with a resistance of twenty ohms for coil and suspension was chosen from the selection offered by Siemens & Halske, and used for all the measurements in division 1. Its period on open circuit is 3.9 seconds, its sensibility 10^{-8} amperes per scale division, with scale 3.2 metres distant. A periodicity was reached with sixty ohms total resistance in the galvanometer circuit. Using this value for the resistance R, the sensibility becomes 60×10^{-8} volts per scale division.

Consider now a measurement with a ratio 1 : 10, where the sensibility of the bridge is less than for 1 : 1. If the test current be adjusted so that there is 0.1 volt (= BC) drop in the larger of the two resistances compared, then for a change $\epsilon = 10^{-4}$ in the resistance the electromotive force in the galvanometer circuit is, according to equation (7),

$$e = \frac{0.1}{11} 10^{-4} = 90 \times 10^{-8} \text{ volt}$$

and this would give a deflection of $\frac{90}{60}$ or 1.5 scale divisions. The double deflection obtained by reversing the current would be three scale divisions, or one scale division corresponds to a change of resistance of the fractional part thirty-three millionths. With the excellent constancy of the zero of this galvanometer, readings can be repeated with an accuracy of three parts in a million. One-tenth volt is not too great a load for resistances down to 0.001 ohm. The larger resistances are loaded more (up to 0.2 volt) and those below 0.001 ohm are loaded less, giving a greater sensibility with the former, and less with the latter. In table 1 the current and sensibility are given for each measurement. For comparisons in the ratio 1 : 1 the sensibility is greater, as the value of $m + 1$ in equation (7) becomes 2 instead of 11.

In conclusion it may be said that the galvanometer used suffices in general for the measurement of small resistances, but an increase in sensibility is desirable for the attainment of greater accuracy.

[1] Compare H. Diesselhorst, *Annalen d. Physik*, ix, p. 461 (1902).

[2] For shunt-boxes suited to this purpose see Ayrton and Mather. *Electrician*, xxxii, p. 627 (1894); H. Sack, *Elektrotechnische Zeitschrift*, xvii, p. 587 (1896); W. Volkmann, *Ann. d. Phys.*, x, p. 217 (1903).

[3] The value of the limiting resistance, at which aperiodicity is reached, is frequently omitted in catalogues and other descriptions, so that false ideas of the practically attainable sensibility easily result from the statements of the internal resistance and figure of merit.

Electric Roads in Italy.

[*From United States Consul-General Guenther, Frankfort, Germany.*]

The Frankfort *Journal of Commerce* states that electric propulsion by means of accumulators on the Italian Meridional route has not proved a success.

The management of the road has therefore been authorized to discontinue this electric system on certain lines and to replace it by steam.

The electric system, however, by trolleys over the ninety-odd miles of the standard-guage railroad along Lake Como has met all requirements.

Some days ago a meeting of interested parties took place at the instance of the chambers of commerce of Milan, Lecco and Chiavenna, which resolved to request the government to immediately establish the trolley system upon the lines of Lecco to Milan. The results with the electric system with a third rail over the forty-five miles of the standard-guage Milan-Varese-Porto Ceresio Railroad have been entirely satisfactory.

The traffic on this line, which connects Milan with Lake Lugano, has increased surprisingly on account of the cheaper rates, number of trains, and quicker time. The management of the road is perfectly satisfied with the financial result.

The Mediterranean Railroad contemplates the extension of the electric system with a third rail over the lines Verese-Laveno-Gallarat-Sesto Calende-Arona, so that then Milan will be directly connected with the upper Italian lakes by four electric standard railroads.

Electric Power in a Lothian Oil Mine.

IN THE Lothian district in Scotland, some miles westward from Edinburgh, is to be found the centre of an industry which, though large and flourishing, is quite unknown to many. The production of oil from the shale in this district employs thousands of hands, and engages much capital, while its mark is writ plainly over the face of the country in the shape of large distillation works with smoky chimneys and enormous heaps of tailings. The raw shale is found in thick veins at moderate depths, in some places outcropping on the surface, and after excavation is passed through numerous processes of distillation and refining. These result in light and heavy oils of various kinds, together with certain saleable by-products. In describing a typical modern plant, it is not our intention to lay stress on the chemical reactions, though these are interesting enough, but rather on the engineering, and especially the electrical features of the installation.

The Oakbank Oil Company is one of the most progressive and prosperous concerns in the trade, and its large plant at Mid-Calder, N. B., lends itself to division under three heads. These are, first, the mines from which the oil-bearing material is extracted; second, the distillation works, and third, the refineries. The mine workings are situated at Dalmeny, a mile or two from the Forth bridge, and just opposite the new naval base, being about two miles distant from the distillation plant at Winchburgh. About seven miles again from Winchburgh are the refining works, to which the crude oil, etc., is conveyed in large cylindrical tanks mounted on double-bogie railway trucks.

The mining is simple, the shafts being driven all the way through the shale itself. The working is all done by hand, methods being employed similar to those used with hard coal. The main shaft is about half a mile in length, sloping down at an average gradient of about one in 4.5, and accommodating a double track for two rows of hutches, full and empty respectively. The hutches are raised and lowered by means of an endless wire-rope haulage gear, designed with a capacity for hauling 100 tons per hour over 400 fathoms on a grade of one in 4.5, at a speed of one and one-half miles per hour. As the average output of this shaft is some 500 tons per eight-hour day, or perhaps 600 tons on a good day, it will be seen that the plant installed allows ample margin for development. The hutches are hitched on to the rope by means of short lengths of chain with hooks on their ends. These chains are first secured to the hutch, and then the hook end is thrown over the moving rope, giving two or three turns round it, and the hook brought back and passed over the "standing" part of the chain. The hold is entirely by friction, but is of ample strength, and very easily loosened at the pithead. On the way down, hutches are detached and run into short sidings in the cross drives, where they are filled up. They are then secured to the ascending rope, and pulled up full. There is thus a constant stream of ascending and descending wagons on the rope at intervals of a few yards. The mine is ventilated by a Capell fan, giving 60,000 cubic feet of air per minute, and driven by a twenty-horse-power motor through gearing. The haulage is continued from the mouth of the shaft up an inclined plane which elevates the hutches to a superstructure containing the shale breakers and bins. On reaching the top level, the hutches are detached from the rope and run into a motor-driven tipping cradle, and discharge their load into hoppers, and are then automatically propelled forward. They are then connected to the other side of the haulage, and again lowered down the shaft. The haulage is driven by a 150-horse-power Westinghouse induction motor, shown in Fig. 1.

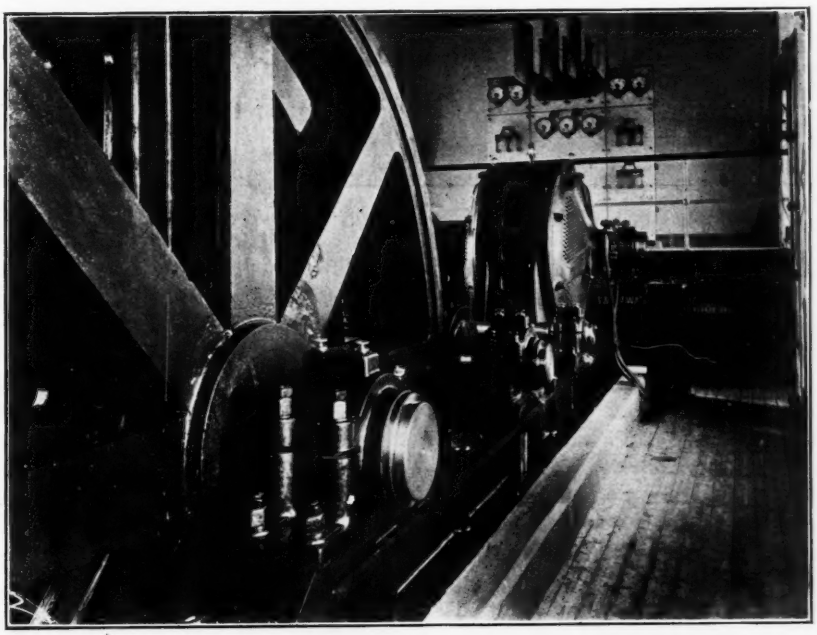


FIG. 1.—A 150-HORSE-POWER INDUCTION MOTOR FOR HAULAGE IN OIL MINE.

From the tipping cradle the shale falls into large hoppers, from which it is again fed into the breaker, which reduces the pieces to suitable size for roasting in the retorts. The breaker is driven by a thirty horse-power motor, which is under the control of a man standing beside the tipping cradle, who can thus start or stop the motor when required. The motor is of the Westinghouse induction type, "CB" pattern, being similar to nearly all the other motors in the installation. It is supplied with three-phase alternating current at 400 volts. It may here be mentioned that one motor of thirty horse-power employed to drive gas exhausters in the distillation plant, see Fig. 2, has been running for, at the time of writing, six months without a single stoppage, and for most of this time without stand-by power. Yet were these exhaust fans to stop for a moment, the gases would rush back into the retorts and cause a serious explosion. The type "CB" motor is controlled by a double-throw switch and an autotransformer.

It is not infrequently the case, however, that speed variation is required of a motor. This is particularly the case for large winding and hauling plants, where it is necessary to start slowly with great power, and where the motor may, further, be required to run for considerable periods at reduced speeds. A case in point is that of the 150-horse-power haulage gear mentioned above. To meet such require-

ments, the variable speed type of induction motor has been introduced.

To return now to the progress of the shale. After passing from the breakers, the broken shale passes down chutes into small hopper wagons, each with a capacity of about 2,500 pounds. These wagons run on a two-foot six-inch gauge track from the mine to the distillation works at Winchburgh, two miles distant, being hauled in trains of about twenty wagons, weighing altogether forty tons. There are two Baldwin-Westinghouse electric locomotives, each fitted with two motors of twenty-five rated horse-power each; one of these locomotives is shown in Fig. 3. They are supplied with current from an overhead trolley wire, of 00 section, at 500 volts. Series-parallel control is not used, the motors being permanently connected in parallel, as is usual with small locomotives, and five resistance steps are provided. The locomotives are designed for a maximum full load speed of about ten miles an hour, and exert, with thirty-inch driving wheels, a starting draw-bar pull of 3,000 pounds, and a running pull of over 2,000 pounds. The loaded trains take about twelve minutes to run the two miles of very hilly track between the mines and the works. The power consumption at the switchboard in the generating station averages about eighty amperes per train at 500 volts, or, say, a little over fifty horse-power, including the transmission loss. This is not at all excessive, remembering that the locomotives are probably not in actual operation half the time, so that the motors have ample time to cool off. The locomotives are essentially strong, compact and workmanlike, and have given all possible satisfaction in service.

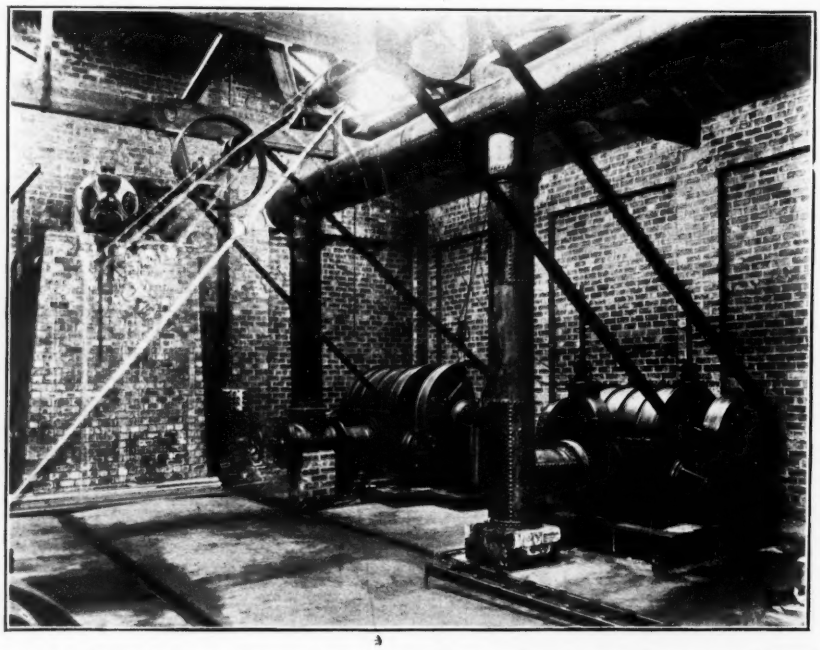


FIG. 2.—A 30-HORSE-POWER MOTOR DRIVING GAS EXHAUSTERS IN THE DISTILLATION PLANTS.

Having arrived at the end of the electric railway, the hopper wagons are picked up by an endless rope haulage gear, worked by a thirty-horse-power induction motor, and run up a long incline. From the top of this, the wagons are pushed by hand, first above chutes leading to a shale storage, in which material is stored during the week for work on the Sunday, when the mine plant is shut down, the distillation plant being in continuous operation. When a sufficient quantity of shale has been discharged into these chutes, the wagons are pushed along to the top of the "benches" of retorts shown in Fig. 4. They are here emptied, the material falling into large storage hoppers holding seven tons each, from which it is fed into the retorts as required.

The shale is roasted in these retorts, and the gas is drawn off by motor-driven exhausters and passed through the large condenser shown to the left in Fig. 4. In this crude manner heavy oil and ammonia water are distilled off, separated and stored in large tanks. The lighter gases in the mixture are drawn through the fans or exhausters and then passed through scrubbers. After being thoroughly cleaned, the naphtha is distilled off, and the remaining gas is utilized to heat the retorts. The ammonia water separated off is converted into sulphate of ammonia, which commands a price of about £13 per ton. The fact that until recently this ammonia was wasted affords a useful lesson in the utilization of by-products.

The refuse from the retorts is conveyed in dump wagons drawn by an endless rope haulage plant, driven by a thirty-horse-power motor to the top of the refuse heap, or "bing" as these are locally named.

In addition to those described, there are a large number of small motor-driven pumps, fans and haulage gears in all parts of these works, and also at the refining works at Oakbank, seven miles distant. Especial mention should perhaps be made of a thirty-horse-power induction

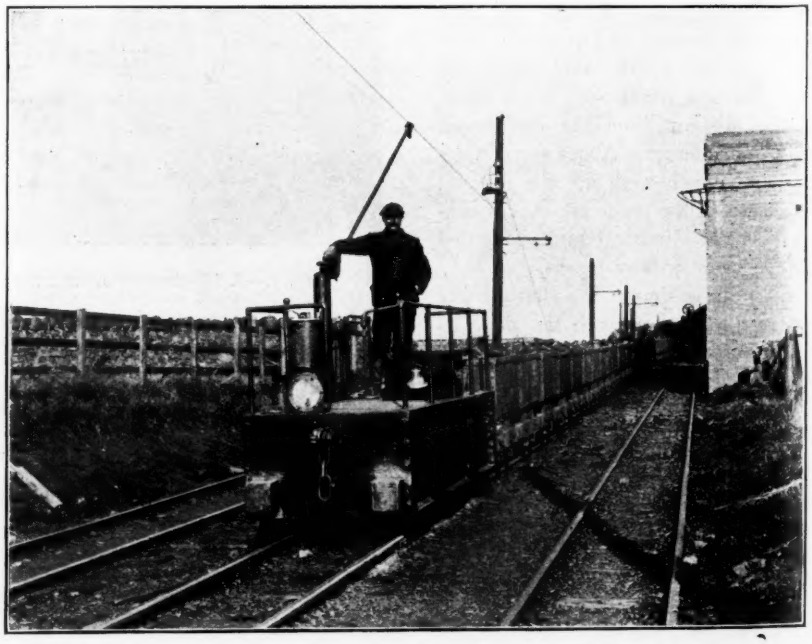


FIG. 3.—SHOWING A BALDWIN-WESTINGHOUSE ELECTRIC LOCOMOTIVE.

motor driving a three-throw pump at the pit bottom. This pump delivers 100 gallons per minute against a head of 110 feet. It is interesting to note that the cables carried down the mine to it are capable of transmitting sixty horse-power, thus allowing scope for extensions.

The central station from which power is supplied to the entire plant is located at the Winchburgh works. There are three Stirling boilers, fitted with chain grate mechanical stokers, all driven by a five-horse-power motor. Steam at 165 pounds pressure is supplied by an eight-inch steam header to two Westinghouse automatic compound engines in the engine room (Fig. 5), with cylinders eighteen and thirty inches by sixteen inches running at 250 revolutions per minute. A back pressure in the exhaust of about seven pounds is due to the utilization of the exhaust steam in certain distillation processes. Under these conditions the engines have a rated full load of about 400 horse-power which is at present about the maximum load on the plant, and thus one engine is able to support it. It is, in fact, the practice to run one engine continuously for a week, and then to change over to the other set. The sets run very quietly and steadily, and have given no trouble whatever. In view, however, of extensions, which will probably make it necessary to keep two sets running, the

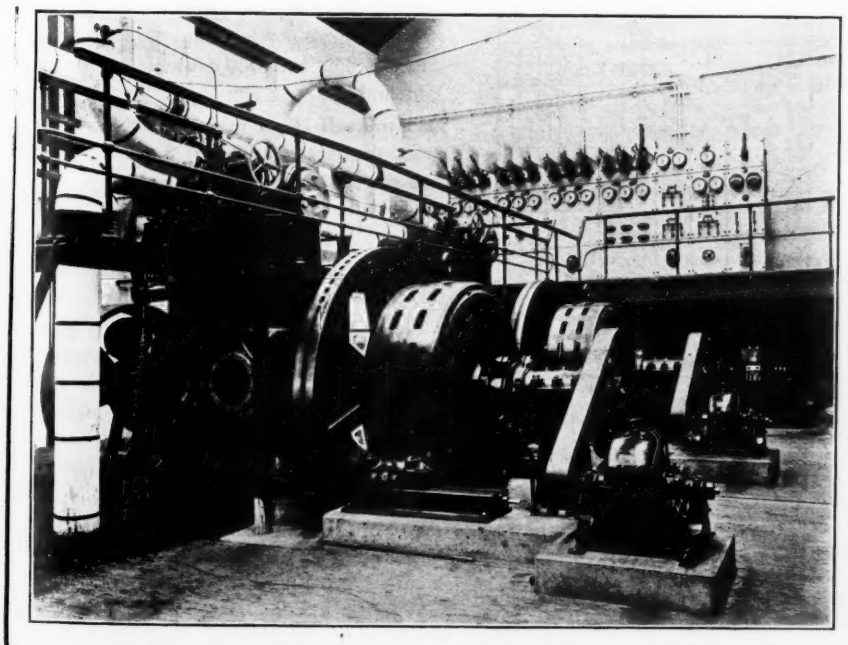


FIG. 5.—SHOWING ENGINE ROOM.

Oakbank company has recently ordered a third unit of similar type.

The generators, which are direct coupled to the engine shaft, are of the Westinghouse rotating field type, rated at 200 kilowatts and delivering three-phase alternating current at 3,300 volts for high-tension transmission, direct, without the use of step-up transformers. Exciting current is supplied by the small 7.5-kilowatt dynamos shown belted to the generator shafts. The two sets of transformers under the switchboard gallery, four of seventy-five kilowatts each and four of 37.5 kilowatts each, step down the high generator voltage to, in the first case, 440 volts, for local motor circuits, and, in the latter case, 330 volts for a 100-kilowatt rotary converter. One of each group of transformers is a spare, the other three being arranged in delta connection. They are of the oil-insulated self-cooling type.

The white marble switchboard comprises seven panels, four high and three low tension, made up as follows in left to right sequence. First, two generator panels, one for each machine, next a feeder panel, controlling the high-tension overhead transmission feeder to the mines,

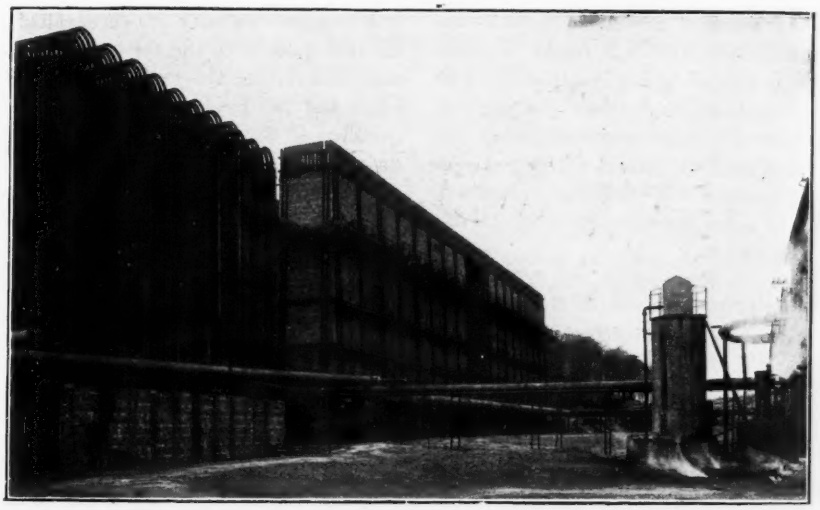


FIG. 4.—SHOWING "BENCHES" OF RETORTS AND CONDENSERS.

and next a transformer panel. Each of these panels has a three-pole high-tension air-break circuit-breaker, with automatic overload action. Next come the low-tension feeder panel, for the motor circuits in the neighborhood of the power-house, the rotary converter panel, and the direct-current railway feeder panel. Wattmeters are mounted on the high-tension feeder, low-tension feeder and direct-current railway feeder panels, their aggregate reading giving the total output of the station. The ammeters and voltmeters, except for the direct-current instruments, are of the long scale type, with very open readings.

The rotary converter, under the switchboard gallery, is, in common with all the electrical plant, of Westinghouse make, and is employed to supply direct current for the railway. Three-phase current is fed to the machine at 330 volts, and direct current at 500 volts collected from the commutator. This machine runs about eight hours a day, being shut down when work at the mines is stopped, and the locomotives have made their last journey for the day. The converter is started up by a small induction motor mounted on a continuation of the shaft.

The advantages attained by the Oakbank company through the adoption of electric power are many. First may be mentioned a great reduction in coal consumption as compared with many mines in the neighborhood, where numbers of isolated steam engines, with the necessary accompaniment of boilers and smoky chimneys, are distributed in all parts of the plant. Then again, there is economy

in labor, for the induction motors used are so simple as to require practically no skilled attention. There is elasticity, for it is possible to put down a motor to drive any new machine with a minimum of trouble and expense. There is safety in the presence of explosive gases and volatile inflammable oils. A degree of cleanliness is secured which is impossible with a multitude of smokestacks pouring soot into the air. But above all other advantages must be classed the convenience of operation, which minimizes danger and delay in many processes to an almost incredible extent.

The Telephone on German Railways.

The employment of the telephone on the Berlin High-Level Underground Railways has proved so satisfactory that its application to long-distance lines is contemplated. It is reported that the Siemens & Halske system has been introduced on the Prusso-Hessian State Railways. The noteworthy features claimed for this system are the joining up of all the batteries at departure and terminus stations. The continuous current supplied by the batteries, at either end, to the telephones on the line not only furnishes the energy for the microphones, but, by the insertion of a current indicator, enables the entire apparatus to be regulated.

Uni-Directional Wireless Telegraphy.

Signor Alessandro Artom, professor of telegraphy and telephony, at the Galileo Ferraris Electrotechnical School, Turin, Italy, is endeavoring to perfect a unidirectional and syntonized system of wireless telegraphy, based on the use of circular and elliptical polarized waves. Experiments were carried out in the gulf of Spezzia during February last, and further trials are now being made at the Monte Mario station near Rome, communication with stations at a distance of 100 kilometres being sustained. The Italian Navy has placed at Professor Artom's disposal various ships, in order that he may continue his experiments over greater distances.

A New Supply of Radium Found.

It is announced that two discoveries of ore containing radium have been made in Utah and Idaho, by Captain James Lawrence, a geologist and mining expert. It is said that the strike is a most important one, and will have the effect of reducing the present price of the metal. The ore has been tested by a New York assayer, and is said to have a large amount of radium in it.

SHOP TESTING OF MOTORS AND GENERATORS FOR COMMERCIAL SERVICE—IX.

(Concluded.)

BY BERTRAND B. ÀBRY.

Having thus determined (e) or the power-factor, we may at once calculate the real watts from the apparent watts as measured during the test, and from this value and the losses proceed to the calculation of the horse-power output and the efficiency. As best illustrating how this calculation is carried out, we give below a set of figures showing the various steps taken.

Refer to the motor and generator speeds as observed during the test. If we consider the generator speed changed to motor speed as being 100 per cent (that is, to the speed the generator would have if the number of poles was the same as that of the motor) and the difference between this and the motor speed (in per cent) as the **per cent slip, then 100% — per** cent slip will give the motor speed in per cent of synchronism, bearing a direct relation to the motor output. The product of the real watts minus the other losses (exclusive of secondary loss) into this 100% —per cent slip, gives the watts output.

5 HORSE-POWER, 2ϕ, 200-VOLT MOTOR.

CALCULATION OF BRAKE HORSE-POWER, REAL AND APPARENT EFFICIENCY.

Amperes.	Apparent Horse-power.	Power-Factor.	Real Horse-power.	Real Watts.	Primary Loss.	No Load Loss.	Real Watts—Losses.	100 %—per cent Slip.	Watts Output.	Brake Horse-power.	Apparent Efficiency.	Real Efficiency.	Speed.	Torque.
15	4.02	67.9	2.72	2025	97.8	300	1627	98.3	1600	2.14	53.2	78.7	982	11.5
20	5.35	78.8	4.23	3150	173.0	"	2677	97.0	2600	3.49	65.2	82.5	970	18.9
30	8.05	84.3	6.79	5050	390.0	"	4360	94.1	4100	5.50	68.5	81.1	941	30.7
40	10.72	85.1	9.12	6800	693.0	"	5807	90.8	5280	7.08	66.0	77.6	908	41.0
50	13.40	83.5	11.19	8330	1085.0	"	6945	87.0	6030	8.09	60.4	72.4	872	48.7

The apparent horse-power is of course obtained from the current and voltage readings taken during the test.

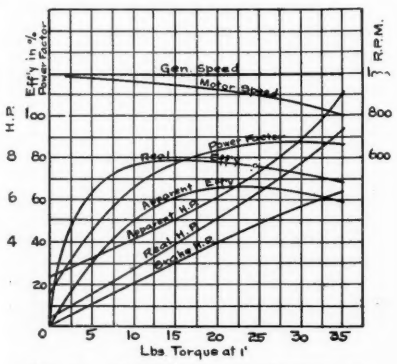


FIG. 27.—CHARACTERISTIC CURVES, 2ϕ, INDUCTION MOTOR.

The real H.-P. = the apparent H.-P. × per cent power-factor.

The real watts = real H.-P. × 746.

The primary loss, assuming this to be a two-phase machine, = $\frac{1}{2}$ I^2 R, where R = resistance of the primary winding per phase, and I = total amperes flowing.

The no-load loss is obtained from the running saturation curve, at the normal voltage. We must subtract from this the no-load I^2 R loss which may be considerable if the air-gap is large; otherwise this loss would be included twice as the primary I^2 R loss is figured from the total amperes. The real watts minus the sum of the primary loss and the no-load loss in watts gives the real watts minus losses. The next column, "100% —per cent slip," is calculated as follows:

From the watts output the horse-power output is readily calculated by dividing by 746.

The ratio of the brake horse-power and the apparent horse-power gives the apparent efficiency, and the ratio of the brake horse-power and the real horse-power gives the real efficiency. Knowing the brake horse-power and the speed, the torque may be readily calculated from the formula:

Brake H.-P. = motor speed in r. p. m. × torque at 1' radius × 2 π / 33,000,

or

Torque = brake H.-P. / r. p. m. × 0.0001904.

Plotting these results on a torque base, we have the characteristic curves of an induction motor as shown in Fig. 27. which indicates the relation and general shape of such curves.

5. Temperature Test—With induction motors this test is made for the same purpose as similar tests on other machines. As a usual thing, the smaller size motors are run at full load and full voltage for one hour. In the case of large-size machines the temperature run is usually for a longer period.

6. Insulation Test—After the temperature run is concluded it is customary to test the insulation of the machine. The alternating-current voltage applied varies with the normal voltage of the machine, and the test is usually made from windings to ground.

INDUSTRIAL ELECTROCHEMISTRY AND ELECTROMETALLURGY—VII.

NOTES ON PROGRESS IN EUROPE AND AMERICA.

BY JOHN B. C. KERSHAW.

Electrolytic Copper.

In a note published in the ELECTRICAL REVIEW of March 21, 1903, reference was made to the Desolle improved process for depositing copper electrolytically. This process depends upon the use of jets for delivering the electrolyte under pressure against the face of the cathodes, in order to enable high-current densities to be used. The writer expressed the opinion that in view of the earlier trials of a similar method in England and America, the Desolle process and patents contained nothing new; and the winding up of the Desolle Electroplating Company, recently announced, is an interesting confirmation of this judgment. The experimental plant of this company was located at Birmingham, England, and the process was also in operation at the works of Levallois-Perret in France. Another electrolytic copper refinery that has ceased operations is that of the Chicago Copper Refining Company, America.

In spite of the setbacks, the copper refining industry continues to develop, and according to statistics published by T. Ulke in various journals during the present year the daily output in the United States is 764 tons, equal to 279,000 tons per year. The amount of silver and gold now annually recovered from the slimes in America is given by the same authority as 27,000,000 ounces and 346,020 ounces, respectively. The aggregate value of these recovered "impurities" is about $20,000,000. These figures and values prove the wonderful success of the industry in America, and the dependence upon the "impurities" for covering the cost of the refining process. The absence of these impurities in the copper mined in Europe explains the lack of expansion shown by the industry in France, England and Germany. Ulke gives the following as the number of refineries operating in the various countries at the date of his enquiry:

United States	9
Germany	9
France	4
United Kingdom	6
Austria-Hungary	2
Russia	2
Total	32

The proportionate contribution to the total annual output of refined copper he estimates as follows:

United States	86.5
Germany	2.75
United Kingdom	8.8
France	1.6

The chief recent improvement in the refining process, according to Ulke, is the use of anodes double the thickness of those formerly employed, with consequent saving in labor charges and in losses due to disintegration in the cells.

Hofman, in a recent contribution to the American Institute of Mining Engineers, has given very full details of the refining process as worked out at the Anaconda and Great Falls refineries, and has made some interesting remarks on the methods used for treating the anode slimes.

Electrolytic Bleach, Finance.

In a note published in the issue of the ELECTRICAL REVIEW for December 5, 1903, the writer referred to the effects of open competition in the bleaching powder industry upon the profits of the electrolytic alkali companies, and also to the prospects of a revival of the old agreement between various producers, as regards output and price. Since that note was penned the Castner-Kellner Alkali Company, of Liverpool, England, has published a notice to its shareholders, stating that the financial situation in the alkali and bleach industry will not permit it to distribute the usual interim dividend on its ordinary shares. Although this company has a strong reserve, the announcement that it had passed its dividend caused the ordinary shares to fall heavily in value, and the £1 shares were quoted five shillings below par immediately after the circular of the board.

It, therefore, seems likely that the effects of a continuance of the open competition in the bleaching powder industry would be fraught with serious consequences, even with the best managed of the electrolytic works. The report that the various producers are negotiating for the revival of the old arrangement in a modified form (see the *Manchester Courier*, December 3, 1903) will therefore be received with satisfaction by all interested as shareholders, either in the Le Blanc or in the electrolytic works.

If bleaching powder is maintained at a price of from $22 to $25 per ton, it would leave a fair margin of profit for the producers in the United Kingdom, and at that price the users of this chemical as a bleaching agent would not be unfairly handicapped.

The low price at which bleaching powder has been sold during the past year has, in fact, hampered the development of two electrolytic industries. The manufacturers of alkali and bleach by the electrolytic methods have been unable to earn satisfactory profits, and, in many cases, have been compelled to shut down all or portion of their plant, while the inducement for bleachers to use sodium hypochlorate, produced electrolytically, in their own works, has been non-existent, owing to the fact that bleaching powder was selling below cost price in the open market.

A New Application of the Electric Furnace.

France is certainly the present home of electrometallurgy, and therefore it is not surprising to learn that the government of Chili has sent an expert to that country in order to learn and study the possibilities of the electric furnace, as applied to the smelting of the cupriferous ores of Chili. The idea underlying this investigation is, that if the electric furnace can be employed for this purpose with satisfactory results, Chili, which is rich in water power but poor in natural fuel, might smelt at home the copper ores at present exported to other countries. M. Vattier, the expert charged with the investigations, has been conducting experiments at different electrometallurgical works in France with Chilian ores since the spring of 1903, and fairly full details of the results obtained have recently been published in various French and German technical papers. At the Le Praz works of Heroult a current of 3,500 to 4,000 amperes at 110 volts was employed for twenty-four hours to smelt eighteen tons of ore, containing seven per cent copper. The matte obtained in this experiment contained forty-three to forty-five per cent copper. At the Livet works of Keller, Leluce & Cie. a charge of ore weighing 8,000 kilogrammes containing six per cent copper was introduced into a 300-kilowatt furnace, and was heated for eight hours by the electric current. The matte carried forty-three per cent copper, and the slag only carried off 0.10 per cent. The further treatment of the regulus or matte is designed to take place by ordinary metallurgical methods. The electrical energy thus only dispaces the coke used in the preliminary smelting operation. Coke costs 100 francs ($20) per ton in Chili, and the cost of smelting copper ore there by the usual process is stated to be 320 francs ($64) per ton of copper produced. The estimated cost of smelting when using water power is only eighty-three francs ($16) per ton, inclusive of the costs of carbon electrodes (forty-five francs) for the electrical furnace. If these figures are correct, the electrical method of treatment would certainly appear to have a future, under some circumstances and conditions. The comparison, however, of costs ought to be made not as above, but between smelting by coke in South Wales or Baltimore, plus freight of ore, and smelting by electric power in Chili or other mining centres, plus freight of copper matte to Swansea or Baltimore. It is possible that if the costs comparison were made on this basis, the balance in favor of the electrical method would not be so startling as that shown in M. Vattier's estimates.

ELECTRICAL MINING NOTES.

ELECTRICITY IN THE SOUTH AFRICAN GOLD MINES.

BY SIDNEY F. WALKER.

In South Africa, as pretty well elsewhere, electricity is making its way against the opposition of its great rival compressed air. In European collieries, electricity has several rivals, the horse, steam, ropes and compressed air, but in the South African mines only steam and compressed air appear to have any serious effect upon its advance. Steam also is gradually being displaced by electricity. That is to say, the process which is going on everywhere else is going on in South Africa; steam is being put into its proper position—generating electricity for distribution, or compressing air for the same purpose, and not being used for small engines, locomotives, etc. Up to the present, compressed air and electricity have practically divided the control of certain portions of the work, while other portions are gradually being delivered over to electricity. Thus pumping has been done almost entirely by electricity, while rock drills have been almost as entirely worked by compressed air.

WHAT A GOLD MINE IS LIKE.

Perhaps it will be of some service to those who may have to supply apparatus, if the arrangement of a gold mine is described. A coal seam, as described in these pages, lies in a basin. If we imagine a large, irregular, shallow pudding basin, with layers of paste, and layers of fruit or meat alternately placed on the inside for a certain depth, the remainder being filled in with paste, the layers of fruit or meat will represent the coal seams, while the paste will represent the other strata. The portions of the seams which are near the outcrop, as it is termed, are inclined at different angles with the horizontal, according to their position, while the portions which are near the bottom of the basin are almost flat. In gold, tin and other metalliferous mines, the lode, as it is called, nearly always lies at an angle with the horizontal, and in the majority of cases the inclination is fairly steep. It is as though the outcrop portion of a coal seam was continued down at the same inclination as it assumes near the outcrop. Put in another way, imagine a furrow, at an angle with the vertical, but cut irregularly, and running down to almost any depth, and you have the lode of a gold or tin mine. The gold deposits have been placed where they are found, sometimes by the action of water, by rivers which have since ceased to run, and whose beds have been covered up. In other cases, huge fissures have been formed in the strata into which molten gold or tin appears to have been squirted. The fissures are very irregular, sometimes taking the form we associate with lenses, and at others taking more or less the form of simple cracks in the adjoining strata. The method of getting the ore is the same, whatever the form of the lode. The metal, it should be mentioned, is held in mechanical suspension, usually in the stone which carries it. Even where the pure metal itself is not present, the substance containing it in combination is held in mechanical suspension in the pores, practically, of the rock in which it lies, and the process of obtaining the metal, gold or tin, consists in detaching the gold-bearing rock from its bed and crushing it to fine powder, and then separating the gold partly by gravitation and partly by chemical action. Shafts are sunk in the gold-bearing rock, the reef, as it is termed usually, and at different depths levels are run off into the reef, which are again connected together by short shafts, called winzes or upraises, according to whether the small shaft is run from an upper level to a lower, or *vice versa*. In some cases vertical shafts are sunk, and levels or roads are driven through the strata to the reef. It will be understood that as the rock which bears the gold is very hard, it may be cheaper to sink a vertical shaft, though the lode itself is inclined at a considerable angle to the vertical, as a vertical shaft has certain advantages under certain conditions. Also the angle at which the lode lies is nearly always very irregular. In Cornwall, where the shafts invariably follow the lode, the direction of the shaft is constantly changing, so that any one riding in the "skip"—the box in which the ore is brought to the surface—has a very unpleasant experience. Part of the time he is lying at a certain angle on his back, then suddenly the "skip" will turn over, and he will have a feeling almost that he is head downward. "Skip" riding is strictly forbidden, but the law is sometimes evaded. Also where the angle at which the lode dips from the vertical is considerable, sinking may have to take place on property where the lode does not outcrop, and a vertical shaft in that case becomes necessary to strike the lode. The cases where vertical shafts are sunk are similar to that of a coal mine which is sunk on the inclined portion of the basin. The vertical shaft is continued by an incline running in the lode. Several shafts are sunk on each property, where it is of any extent, and the stone is sometimes brought to the nearest shaft and drawn to the surface. Sometimes one shaft only is used for drawing. This is the latest practice. After the stone reaches the surface it has to be taken to the mill to be crushed, and the mill is usually some little distance away, so that some form of haulage is necessary. In some of the mines the ore is loaded into large twenty-five-ton trucks, and hauled by steam locomotives, but at other mines electrical haulage has been put down. At Knight's Deep, and at Simmer and Jack East, electric haulage plants have been installed for the purpose of hauling the ore from the mine to the mill, and for hauling the coal from the bunkers at the mill, where it is delivered from the railway, to the boilers at the mine shaft. At one of these the haulage system is by electric locomotive, while at the other it appears to be by rope. The crushing of the ore is carried out by various machines, such as the well-known stonebreakers, but the principal machine is the stamp, consisting of a heavy iron pillar, fitted with a shoe at the end and a tappet or ring projection at a certain height. A shaft runs along by the side of a battery of stamps, carrying a number of cams, one for each stamp. As the shaft revolves, the cam engages the tappet projection on the pillar of the stamp, raises the whole thing, and at a certain point allows it to drop on to the die, where the ore to be crushed has been placed. A number of stamps are worked together in a battery, the noise being something like the roaring of the sea, and to be heard for miles round. After the preliminary breaking up by stonebreakers, and before coming to the stamps, the ore is sorted on tables or belts, similar to those used in coal mining work, the tables consisting of circular discs fixed horizontally and revolving on vertical axes. The sorters stand round one portion of the edge of the disc and pick off any of the stone which appears to them not to contain metal, the stone being delivered to the table at another part of its edge. With the picking belt, a long belt, usually now constructed of a series of plates of steel, so as to be flexible, runs in a sort of trough, by the side of which are the sorters, who pick out what is not good or the reverse. From the stamp mills, the ore passes to various machines, where, with the aid of water, centrifugal force and gravity, the metal is separated from the dross. After all this, however, the tailings are taken to

the cyaniding plant, where they are subjected to the successive action of cyanide of potassium and zinc, and the remainder of the metal extracted. All of the machines, the crushing rolls, the stamps, the classifiers, the jiggers, the buddles and the remainder of the apparatus require to be driven mechanically, and the electric motor is about the handiest and most economical apparatus for the purpose for pretty well all of them. All the large mines have electric power stations, but all of them have not adopted electric motors for driving the important machinery. The stamps, for instance, are usually driven by their own steam engine, though there appears to be no reason that electric motors should not be employed. It is one of the cases where the weaknesses of the electric motor do not come in. Most electrical engineers who have assisted in the development of the use of electricity for power work have feared the use of electric motors where sudden strains are brought to bear on the motor, as when a hot steel billet is first placed between the rolls to be made into a steel rail. The power absorbed goes up from nothing, or only that due to the friction of the rolls themselves, to several thousand horse-power, and as suddenly goes back to nothing. The same thing applies in a smaller degree to crushing machinery such as those in which a pair of jaws catch the stone between them, and break it up into small pieces. The difference in the strain upon the motors, between when no stone is in the machine and when the jaws encounter the stone, is very serious. There is the same thing, in a smaller way, in a circular sawmill, when a big piece of wet timber comes under the saw. But there is one rule for all these cases: make the motor well above its work, so that even the very heaviest load, the very heavy torque at starting, shall not be in excess of its possible load, and all will be well. With the stamp battery, however, there is none of this. The load is known at all times. There are so many stamps to lift each minute, such a distance, and the friction of the apparatus, and that is all. Any uncertainty in the results does not affect the work to be done on the stamp. There is, of course, the question of the economy of a stamp mill, but that does not affect the question of the use of electricity for driving them. In the Barberton district, for a long time before the war and since the war has finished, the whole of the appliances of a gold mine have been driven by electric motors, furnished with current from a supply station some miles away, deriving its energy from water power.

IN THE MINE ITSELF.

In the mine itself, the openings are for winding, for pumping, for haulage, for drilling and for ventilation. As already remarked, for pumping, electricity is the agent par excellence recognized on the Rand. Apparently it has fully justified its choice. In the Knight's Deep mine, some motors and cables which had been used for pumping before the war were left, and are stated to have been under water for two and one-half years, and to have been taken out, dried and put to work again with satisfactory results. The name of the maker of the motors is not given. At this mine also 2,500,000 gallons of water were pumped out every twenty-four hours for five months. This means something like an expenditure of 10,000 horse-power on pumping alone for the period named at that mine. It should be mentioned that it is a common feature of metalliferous mines, certainly of tin and gold mines, to be very much burdened with water. The rock which carries the metal is water bearing. In some cases the water is to a certain extent a blessing in disguise, providing it does not cost too much to pump, as a large quantity of water is required for the machines which separate the gold or tin and the dross, the gangue.

At the Robertson shaft of Knight's Deep mine three electrically driven high-lift three-throw pumps have been put down capable of delivering 400,000 gallons of water per day of twenty-four hours, against a head of 1,250 feet.

DRILLING.

Drilling should offer a good opening for electricity. At present, as already mentioned, the drilling is almost entirely done by compressed air, except where it is done by hand. In the process of getting the stone in which the metal is held, and whether it be in the process of shaft sinking, driving levels, cross-cuts, stoping, as it is called, taking out as much as is possible from the lode, between the levels, holes are drilled, and the stone broken down by shots of dynamite or other explosive. In early Cornish practice, which still rules in Cornwall for small work, the holes were drilled by hand. This practice held its own until the advent of the compressed air drill. None of the so-called labor-saving appliances could beat a pair of Cornishmen who knew their work, using their drills and sledges. The compressed air drill, striking about 500 blows a minute, has taken the place of the hand drill pretty well all over the world.

In coal mines very great attention is paid to the matter of ventilation, because the air current is required to dilute the inflammable gases which are given off from the coal as much as to provide fresh air for the miners to breathe. But in metalliferous mines, there is not this incentive. There is no gas to be feared. Also ventilation, with the system of working tin and gold mines, is not an easy matter. Under these circumstances the fresh air coming from the exhaust port of the compressed air drill is a Godsend, though it is not much in actual quantity. As will be understood also, the temperature at the depths at which "stoping" is carried on is pretty high, and men who are working hard feel very kindly toward the apparatus which gives them a little cool air. There is a more important reason than all, however, *viz.*, the unsatisfactory nature of the electrically worked drills that have been put upon the market up to very recently. This matter of drilling by compressed air, or by electricity, is very closely connected with the very troublesome question, at the present time, in South Africa, of labor. Every manager in the district complains of the shortness of labor, and it is not white labor, that apparently is plentiful enough, though its quality seems to be sometimes a doubtful quantity. It is native labor that is wanted, because the native, working on the same lines as the early Cornish miners, with hand drill and hammer, can drill at a less cost than the machines can do, worked by the expensive white man, and fed with the equally, or more, expensive compressed air.

WHY ELECTRIC ROCK DRILLS HAVE NOT COME TO THE FRONT MUCH.

The reason why the electric drill has not done much yet, is that the problem is a very difficult one. There is no difficulty in producing a rotary drill, electrically driven. But for the great majority of work in connection with gold mines the rock to be drilled is very hard, and requires a percussion drill. Practically all electric percussion drills work on the system that some form of spring really strikes the blow, the electric motor winding the spring up. The effective working of the apparatus depends really upon the springs remaining good, and unfortunately every one knows how unreliable springs are apt to be under conditions such as would rule here. Nevertheless, whoever solves the problem of a good electrically driven percussion rock drill will render working very much more economical on the Rand and other places where tin or gold are got. Perhaps a suggestion of the lines upon which the thing could be worked may not be amiss. It appears to me that the elastic properties of compressed air should be used, but that the air should not be compressed on the surface and distributed to the workings, that it should not even be compressed in the workings, and conveyed to the drills, though that would be a distinct advance, but that the electric motor should compress the air in the working parts of the drill itself. The air should be compressed to a pretty high pressure by the motor, and made to do the work which the springs do now.

Guard Wires for Transmission Lines.

By Alton D. Adams.

LIGHTNING in its various forms is the greatest danger to which transmission systems are exposed, and it attacks their most vulnerable point, that is, insulation. The lesser danger as to lightning is that it will puncture the line insulators, and shatter or set fire to the poles. The greater danger is that the lightning discharge will pass along the transmission wires to stations and substations and will there break down the insulation of generators, motors or transformers. Damage by lightning may be prevented in either of two ways, that is, by shielding the transmission line so completely that no form of lightning charge or discharge can reach it, or by providing so easy a path from line conductors to earth that lightning reaching these conductors will follow the intended path instead of any other. In practice the shielding effect is sought by grounded guard wires, and the easy path for discharge takes the form of lightning arresters, but neither of these devices is entirely effective.

Aerial transmission lines are exposed to direct discharges of lightning, to electromagnetic charges due to lightning discharges near-by, and to electrostatic charges that are brought about by contact with or induction from electrically charged bodies of air. It is evidently impracticable to provide a shield that will free overhead lines from all of these influences. To cut off both electrostatic and electromagnetic induction from a wire and also to free it from a possible direct discharge of lightning, it seems that it would at least be necessary to completely encase the wire with a thick body of conducting material. This condition is approximated when an electric circuit is entirely beneath the surface of the ground, but would be hard to maintain with bare overhead wires. It seems, however, that grounded guard wires near to and parallel with long aerial circuits should tend to discharge any high electrostatic pressures existing in the surrounding air, to check in some uncertain degree both static and electromagnetic induction in these circuits, and to materially reduce the probability that a direct discharge of lightning will choose the highly insulated circuits for its path to earth. Lightning arresters are much more likely to conduct induced than direct lightning discharges to earth, without damage to transmission lines, so that both arresters and guard wires may logically be used in the same system.

Wide differences of opinion exist as to the general desirability of grounded guard wires on transmission lines, both because of their undoubted disadvantages and because the degree of protection that they afford is uncertain. It seems, however, that both the merits and defects of guard wires depend in large degree on the kind of wire used for the purpose, and the method of its erection. Galvanized iron wire with barbs every few inches has been more generally used for guard wires along transmission lines than any other sort. Sometimes a single guard wire of this sort has been run on a pole line carrying transmission circuits, and the more common location of this single wire is on the tops of the poles. In other cases two guard wires have been used on the same pole line, one of these wires being located at each end of the highest cross-arm and outside of the power wires. Besides these guard wires at the ends of the top cross-arms of a pole line, a third wire has in some systems been added at the tops of the poles. These guard wires have sometimes been secured to the poles and cross-arms by iron staples driven over the wire and into the wood, and in other cases the guard wires are mounted on small glass insulators. Much variation in practice also exists as to the ground connections of guard wires, such connections being made at every pole in some systems, and much less frequently in some others.

With all these differences in the practical application of guard wires it is not strange that opinions as to their utility do not agree. Further reason for differences of opinion as to the practical value of guard wires exists in the fact that in some parts of the country the dangers from lightning are largely those of the static and inductive sort, that are most effectively provided for by lightning arresters, while in other parts of the country direct lightning strokes are the greatest menace to transmission systems. At the present time, knowledge of the laws governing the various manifestations of energy that are known under the general head of lightning is very imperfect, and the most reliable rules for the use of guard wires along transmission lines are those derived from practical experience.

A case where a guard wire did not prove effective as a protection against lightning is that of the San Miguel Consolidated Gold Mining Company, of Telluride, Col., whose three transmission lines ran from the water power plant to points from three to ten miles distant, as described in vol. xi, A. I. E. E., 337 and following pages. This transmission operated at 3,000 volts, single-phase, alternating, and the pole lines ran over the mountains at elevations of 8,800 to 12,000 feet above sea level, passing across bare ridges and tracts of magnetic material. It was stated that the country over which the circuits ran is so dry and rocky that it was practically impossible to secure good ground connections along the line, and no mention was made of the way in which the guard wire was grounded, or of the number of its ground connections. Furthermore, it does not appear that there was more than one guard wire on each pole line. Under these circumstances, and with a certain make of lightning arresters in use at the station, lightning was a frequent cause of damage to the connected apparatus. The insulation of some of the machinery is described as honeycombed with perforations which led to continual leakage, grounds and short-circuits, which seems to indicate that the damage was being done by static and inductive discharges rather than by direct lightning strokes, any one of which would have disabled a machine at once. The type of lightning arrester in use on this system was changed, and thorough ground connections were provided for the new arresters, after which the damage by lightning came to an end. It is not stated, however, that the guard wires were removed. This case has been referred to as one in which guard wires failed to give protection, but as may be seen from the above facts, such a statement is hardly fair or accurate. In the first place it does not appear that the single guard wire on each pole line was effectively grounded anywhere, and it evidently was not so grounded at frequent intervals along the lines. Again, a large part of the damage to apparatus appears to have been the result of static or inductive discharges that could not in the nature of things have been prevented by a guard wire. Finally, as the guard wire was not removed after the new lightning arresters were erected, it is quite possible that this

wire prevented some direct discharges over the transmission wires that would have been very destructive.

On page 381 of the volume of A. I. E. E. above cited, it is stated that the frequency and violence of lightning discharges that entered a certain electric station on Staten Island were much less after guard wires had been erected along the connected circuits than they were before the guard wires were put up.

It is also stated on page 385 of the same volume that examination of statistics of a number of stations in this country and Europe had shown that in every case where an overhead guard wire had been erected over power circuits, or where these circuits ran for their entire distance beneath telegraph wires, lightning had given no trouble on the circuits so protected. Unfortunately the speaker who made this statement did not tell us where the interesting statistics mentioned could be consulted.

On the first pole line erected for power transmission from Niagara Falls to Buffalo two guard wires were strung at opposite ends of the top cross-arm on guard irons there located. This cross-arm also carried two power circuits, and the nearest wires of these circuits were distant about thirteen inches from the guard irons. These guard wires were barbed and grounded at every fifth pole, according to an account given in vol. xviii, A. I. E. E., at 514 and following pages. The character of the ground connections is not stated. Much trouble in the way of grounds and short-circuits on the transmission lines was caused by these guard wires at times when they were broken by the weight of ice coatings and wind pressure. As a result of these troubles the guard wires were removed in 1898. Since that date it appears that the transmission lines between Niagara Falls and Buffalo have been without guard wires. Up to 1901, according to page 537 in the volume just cited, twenty per cent of the interruptions in operation at the Niagara plant were caused by lightning, and it seems probable that this record applies to the period after 1898, when the guard wires were removed. It is also stated that during a single storm the line was struck five times, and that five poles with their cross-arms were destroyed. If these direct lightning strokes occurred while there were no guard wires along the line, as seems to have been the fact, it is a fair question whether such wires well grounded would not have carried off the discharges without damage. In California, the country of long transmissions, the use of guard wires along the pole lines is quite general. Many of these lines run east and west across the state, and a single line may thus have elevations in its different parts all the way from that of tide water up to several thousand feet above sea level. Unless guard wires are strung with these lines there is much manifestation of induced or static electricity, according to an account at page 538, in vol. xviii, A. I. E. E., where it is said that in the absence of guard wires a person will be knocked off his feet every time he touches a transmission wire that is entirely disconnected from the source of power. It is also said that this static charge on idle power lines is sufficient, in time, to puncture the insulation of the connected apparatus. On the other hand, where the grounded and barbed guard wires are strung over the entire lengths of these long power lines, these lines may be handled with impunity when they are idle. Ground connections to the guard wire are said to be made at about every fourth pole, and to consist of a wire stapled down the face of the pole and joined to an iron plate beneath its butt. The barbed guard wire itself, of which each pole line appears to have but one, is regularly stapled to the tops of the poles.

At the reference just named it is related that on a certain transmission line running east and west across the state for a distance of forty-six miles, and protected by a guard wire, no trouble was experienced during a severe storm that swept north and south over the line. Meantime the damage on other lines in the same neighborhood, and presumably not protected by guard wires, was large.

Between the electric plant at Chambly, on the Richelieu river, and Montreal, Quebec, a distance of 16.6 miles, a transmission line of three circuits on two pole lines, with guard wires, was operated from some time in 1898 to December 1, 1902, or somewhat more than four years. On the date last named the dam that maintained the head of water at the Chambly station gave way, and the plant was shut down during nearly a year for repairs. For as much as three years this line was operated at 12,000 volts, sixty-six cycles per second, two-phase. During the remainder of the period up to the failure of the dam, the line was operated at 25,000 volts, sixty-three cycles, three-phase. In each transmission two pole lines were employed with two cross-arms per pole. One two-phase, four-wire circuit was carried on each of three of these cross-arms. At each end of the upper cross-arm on each pole, and at a distance of fifteen inches from the nearest power wire, a guard wire was mounted on a glass insulator. A third guard wire was mounted on a glass insulator at the top of each pole, and this third guard wire was about twenty-inches from the nearest power wires. Each of these guard wires was made up of two No. 12 B. W. G. galvanized iron wires twisted together with a four-point barb every five inches of length. Poles carrying these lines were ninety feet apart, and at each pole all three of the guard wires were connected by soldered joints to a ground wire that was stapled down the side of the pole, passed through an iron pipe eight feet long, and was then twisted several times about the butt of the pole before it was set in the ground. At three points along the line the conductors consisted of single-conductor underground cables that had an aggregate length of about twenty-five miles. No lightning arresters were employed at the points where the overhead transmission wires joined the underground cables.

These two-phase, 12,000-volt circuits were operated from some time in 1898 to some time in 1902, or about four years, and during that time there was no damage done by lightning either at the Chambly plant, on the overhead line or the underground cable, or at the Montreal substation. This record is not due to lack of thunder-storms, for in the territory where the line is located these storms are frequent and severe. One very severe storm during the period in question resulted in serious damage by lightning on distribution lines at Chambly and Montreal, where the guard wires were not in use, but the transmission line and its connected apparatus escaped unharmed. The path of this storm was in the direction of the transmission line from Montreal to Chambly, and several trees were struck on the way. At the time of this storm and during an entire summer there were no lightning arresters in the power-house at Chambly.

In 1902, when the transmission line just considered was changed from two-phase to three-phase, and its voltage raised from 12,000 to 25,000, the method of protection by grounded, barbed guard wires, as above described, was retained. Two three-phase circuits were arranged on each of the two pole lines, with one wire of each circuit on an upper cross-arm, and two wires of each circuit on a lower cross-arm, so that the nearest power wire on the upper cross-arm is thirty-two inches

from the guard wire, and the nearest power wire on the lower cross-arm is about thirty inches from the guard wire at each end of the upper cross-arm. The guard wire at the tops of the poles is about thirty-three inches from each of the power wires on the upper cross-arm. In this three-phase line there is about 1,440 feet of three-conductor underground cable, and this cable lies between the end of the overhead line and the substation in Montreal. At the juncture of the overhead line and the cables there is a terminal house containing lightning arresters, and there are also arresters at the Chambly plant and the Montreal substation. No lightning arresters are connected to this line save those at the generating plant, the terminal house and the substation.

During that part of the year 1902 in which the new 25,000-volt line was in operation, that is, after the change and up to the time of the failure of the dam, this line and its connected apparatus were not damaged in any way by lightning, and the same is true for the period in which the line was idle pending repairs on the dam. The experience on this Montreal and Chambly transmission is probably among the best evidence to be found anywhere as to the degree of protection from lightning that may be had by the use of guard wires. In spite of cases like that just considered, where guard wires appear to have given a large degree of protection to transmission systems, many important transmissions are operated without them.

An example of this sort may be seen in the transmission line between the 10,000-horse-power plant at Electra, in the Sierra Nevada mountains of California, and San Francisco, a distance of 154 miles, where it seems that no guard wires are in use. Another important transmission line that appears to get along without guard wires is that between the 10,000-horse-power plant at Cañon Ferry, on the Missouri river, and Butte, Mont., sixty-five miles away. On the transmission line between the power station on Apple river in Wisconsin, and the substation at St. Paul, Minn., about twenty-seven miles long, there are no guard wires for lightning protection. Further east, on the large, new transmission system that stretches from Spier Falls and Glens Falls on the north to Albany on the south, a distance in a direct line of nearly fifty miles, no guard wires are employed. On its way the transmission system just named touches Saratoga, Schenectady, Mechanicville, Troy and a number of smaller places, thus forming a network with several hundred miles of overhead wire. Examples of this sort might be multiplied, but those already named are sufficient to show that it is entirely practicable to operate long transmission systems without guard wires as a protection against lightning.

With these examples of transmission systems both with and without guard wires, the expediency of their use on any particular line should be determined by weighing their supposed advantages against their known disadvantages, under the existing conditions. It seems fairly certain from all of the evidence at hand that if guard wires are to offer any large degree of protection to transmission systems such wires must be frequently and effectively grounded. There is certainly some reason to think that the failures of guard wires to protect transmission systems in some instances may have been due to the lack of numerous and effective ground connections. Such for example may have been the case above mentioned, at Telluride, Col. On the other hand, it seems reasonable to believe that the apparently high degree of protection afforded by the guard wires on the Chambly and Montreal line is due to the fact that these wires are connected through soldered joints at every pole with a ground wire that is wound about its base. The nearer that guard wires are located to the power wires on a line, the higher it may be assumed is the degree of protection afforded, but the greater also is the danger that a guard wire will come into contact with a power wire, by breaking or otherwise. It is probable also that the protection given by a guard wire does not increase nearly as fast as the distance between it and a power wire is diminished. Even if one guard wire on a line is thought to be desirable, it does not follow that two or more such wires should be used, for the additional protection given by two or three guard wires beyond that given by one wire may be trifling, while the cost of erection and the danger of crosses with the power circuits increase directly with the number of guard wires. At one time it was thought very desirable to have barbs on guard wires, but now the better opinion seems to be that, as barbs tend to weaken the wire, they lead to breaks and cause more trouble than they are worth. The point where the barbs are located seem to rust more quickly than do other parts of the wire. In some cases barbed guard wires that have given trouble by breaking have been taken down and smooth wires put up instead. If a guard wire is well grounded at least as often as every other pole, its size may be determined largely on considerations of mechanical strength and lasting qualities. For ordinary spans a No. 4 B. & S. G. galvanized, soft iron wire seems to be about right for guarding purposes. Iron seems to be the most desirable material for guard wires because it gives the required mechanical strength and sufficient conductivity at a less cost than copper, aluminum or bronze, and is easier to handle and less liable to break than steel. It was formerly the practice to staple guard wires to the tops of poles or to the ends of cross-arms, but it was found that the wire was more apt to rust and break at the staple than elsewhere, and in the better class of work such wires are now mounted on small insulators, because of the superior mechanical support thus obtained. This practice, as stated above, was followed on the Montreal and Chambly line. In all cases the connection between a guard wire and each of its ground wires should be soldered, and the ground wire should have a large surface in contact with damp earth, either through a soldered joint with a ground plate, by winding a number of turns about the butt of the pole, or by other means.

It is thought by some telegraph engineers that the use of a separate ground wire running to the top of each pole is quite as effective as a protection against lightning as is a guard wire that runs to all of the poles and is frequently connected to the ground.

This practice is mentioned at page 26 of "Culley's Handbook of Practical Telegraphy." Such ground wires are free from most of the objections to the ordinary guard wires. It seems quite certain that a guard wire along an alternating-current line, and grounded at frequent intervals, must act as the secondary circuit of a transformer by reason of its ground connections, and thus absorb some energy from the power circuits. No experimental data are yet available, however, to show how large this loss may be in an ordinary case. It is fairly evident that there must be some electrostatic effects between the working conductors and a guard wire, but here again data are lacking as to the amount of any such effect. On most, if not all, transmission lines the guard wire or wires, if used at all, is placed either above or on a level with the highest power conductors. It is by no means certain, however, that guard wires a short distance below power circuits would not be equally effective with such wires above these circuits. With one conductor of a three-phase circuit mounted on a pin set in the top of a pole, and the two remaining conductors on a two-pin cross-arm beneath, in the method most frequently adopted for transmission lines of very high voltage, it is obviously impracticable to put guard wires either above or on a level with the power circuits. In the latest transmissions there is a strong tendency to omit guard wires entirely, and rely on lightning arresters for protection.

METHODS OF CHARGING FOR ELECTRICAL ENERGY.[1]

BY ELLIS H. CRAPPER.

The uniform meter rate—often termed a flat-rate system—is no doubt a great improvement upon the old flat-rate system, and is in use to a great extent at the present time. At a fixed price the quarterly account is proportional to the consumption, and the undertaker is paid for what he supplies. The large short-hour consumer, however, does not pay his proper proportion of the readiness-to-serve costs, while the long-hour consumer pays more than his just proportion of the same. The latter, although he may take less kilowatt-hours, is more profitable than the former. The system is readily understood by, and acceptable to, the public, and although a fixed rate has the recommendation of simplicity, it is difficult to offer inducements to the most desirable customer. The price per unit varies from fourpence to sixpence. From the nature of the demand, the engineer could well afford to supply the long-hour consumer with some rebate, but, unfortunately, it is the large short-hour consumer—of which the early-closing drapery establishment of considerable dimensions is an example—who expects and demands a reduction on his account, because the kilowatt-hours consumed is large. Discounts, however, are favored by some undertakers, and discount granted may be based upon the number of units consumed. If the duration of service be ignored, then the wrong individual—*i. e.*, the large short-hour consumer reaps the benefit, since it is the rate at which the supply is given, more than the quantity supplied, which augments the costs' curve. The principle in such cases is, therefore, irrational, and the long-hour consumer would be unfairly treated. It would, in fact, be extremely difficult to exactly apportion the proper amount to be deducted between the individual consumers, when the magnitude and duration of the demand vary so considerably with different classes of consumers. The principle of granting discounts is so prevalent in every-day commercial practice that, not only have they been offered to the more profitable customer, but some engineers maintain that discounts should also take in consideration the period of the year. M. de Fodor, for instance, proposed in his paper read at the Paris congress in 1900, to offer three scales of discounts according to the time of the year, one applying from October to February, inclusive, another during March, April, May and September, and a third one from June to August, inclusive. It has been found at Budapest that the bills for current in the months of December and July, respectively, were in the ratio of seven to one, and as the generating station has a minimum load during the summer months, Fodor considers that greater discounts can be given during these months than during the winter months. As an example of his scale of discounts, it may be mentioned that a consumer having 20 lamps installed and using 440 lamp-hours on the average is supposed to use 1,200 and 1,000 lamp-hours in January and February respectively, and would be allowed a discount of 20 per cent for consumption in excess of these amounts. For the other months the scale is given in the following table:

Month.	Consumption in Lamp-Hours Before Discount Allowed.	Percentage of Discount for Excess.
March	720	40
April	580	
May	380	
June	240	60
July	200	
August	280	
September	580	40
October	1,000	20
November	1,280	
December	1,340	

The main idea is that this system will educate the public to understand the advantages of electric lighting during the period of low tariff; on the other hand, there must, of necessity, be some extra trouble in preparing the accounts. A similar system has been introduced at Les Halles, Paris, but in this case the customer pays a fixed amount, with an addition proportional to the consumption. The correct method of giving a rebate would necessitate the division of the consumers into groups of equal value to the station, with regard to profitableness rather than the magnitude of the consumption. And this idea introduces the principle of a sliding scale of charges, which is justifiable from the point of view that the service demanded of the station may be more cheaply rendered to long-hour consumers than to large short-hour consumers. Sliding scales, however, have not been introduced to any great extent on account of the difficulty experienced in getting out the accounts. The best-known example of a sliding scale charge is the one which was in use at Ayr for some time, and consisted in giving discounts to the consumers according to the duration of their demands, which in the case of shopkeepers were fixed by the hour of closing. Shops closing at seven o'clock received no discount; public houses, restaurants, etc., closing at 10 P. M., received twenty-two and one-half per cent, and private houses thirty-five per cent.

Two-Rate Meters—On the assumption that the production costs are less between certain hours of the day than at periods in the neighborhood of the time of the peak, a system has been proposed by some engineers (and has been introduced to some slight extent) in the shape of a differential rate, depending upon the period of the day at which the demand is made, and electricity is offered at a low rate at periods of light load and at a higher rate at periods of heavy loads. Although by some this is considered a satisfactory principle, it appears to be unsound, and nothing more than a special inducement in the nature of bargain hunting to use lamps when the natural light is available with the exaggerated idea that the hollows of the load curve will be filled up, and the curve be flattened. Now, while it is desirable to encourage the full use of all the lamps for as long as possible and at times other than at the peak load, it ought to be remembered that, in a general way, the consumer only requires light when the natural light fails, and, except (1) in the case of basement property where artificial light is more or less necessary and (2) at special times, as at the dawn of day, there appears to be no reason (omitting, of course, considerations of motor day loads) why a day supply should be fostered by selling electricity, say, at half-price, and introducing a more prohibitive rate when the natural demand should take place, while to the majority of consumers the inducement is offered when electricity is not a necessity. Surely, this is equivalent to offering a bounty to the low-load consumer, inasmuch as a two-rate system, as ordinarily used, tends to flatten the load curve by reducing the peak, instead of building up the low-load curve. The only *raison d'être* of the differential time-rate system is that an early morning consumer making a reasonable demand should meet with some encouragement in the shape of a diminished charge, since he then contributes less to the peak, and his charge may with advantage be based upon, and correspond to, the actual output of the station as a whole, provided such charge contributes something to the standing-by charges. It thus differs from the ordinary demand system, since the charge depends only on an individual demand. Considerations of Hopkinson's fundamental principles as regards the total cost of production impress one with the fact that the ideal tariff should be

[1] Abstract of paper read before the Leeds (England) local section of the Institution of Electrical Engineers.

based on a principle which apportions to each consumer an amount for his service which is commensurate with the total cost of the same, and with this end in view certain systems, described in this paper, have been introduced. Hopkinson's system is a rate which is composed of a fixed charge on the demand installed, plus a charge per unit actually consumed, while Andrews's systems is a rate which is composed of a fixed charge on the demand taken, plus a charge per unit actually consumed, and the last, or Wright's maximum demand, system is a differential meter rate varied by the time the maximum demand is used. Hokpinson's, or the Manchester, system has not been adopted to any extent, as it is obvious that any scale which includes a fixed charge per lamp capacity seriously tends to restrict the number of lamps installed. It has also the defect that the number of lamps may be increased without notice being given of the change. At Burnley the fixed charge is £8 per annum per kilowatt of maximum demand, plus the charge of twopence per unit consumed, with the option of a uniform tariff of sixpence per unit, with discount for prompt payment. The system introduced at Hastings by Mr. Leonard Andrews is a modification of the Hopkinson system, and embodies a fixed charge for the maximum number of lamps simultaneously lighted during the quarter, plus a fixed price per unit consumed. The actual rate is ten shillings per annum per eight-candle-power lamp, paid quarterly, plus one and one-half pence per unit consumed, with the option of a uniform tariff of sixpence per unit. The maximum number of lamps in use simultaneously is ascertained by a demand indicator calibrated in lamps, a "lamp" being assumed to take 0.35 ampere at 100 volts. Mr. Arthur Wright's system is an improvement of Hopkinson's method, and takes into account the actual maximum demand instead of the maximum possible demand, and in addition gives a rebate according to the customer's load-factor. It probably more nearly approaches the ideal system than the others, in that the charge made to the consumer more nearly approaches the cost he occasions than they do. It is questionable whether a charge based on the maximum demand irrespective of the time which it occurs tends to improve the condition of the load, and whether it does not encourage a liberal installation and consumption of current by keeping down the maximum demand. As evidence that the system is not quite perfect, it may be mentioned that when an abnormal and exceptional demand, made for special occasions or purposes, exceeds the normal maximum demand, permission is usually granted for cutting out of action the indicator, provided due notice be given to the officials beforehand and request be made for them to short-circuit the indicator for the occasion. Then, again, the large short-hour consumer is unjustly penalized, while the small shopkeeper who lives over his shop receives more than his just share of the benefits attending long-hour consumption. It is also somewhat difficult to get the layman to understand the principle upon which the charge is made, and considerable objection has been raised to the system on this score alone. And, as Mr. Andrews has pointed out, there may, in some extreme cases, be considerable irregularity in the magnitude of the quarterly accounts.

With respect to the special charges made for power, cooking and heating, it is generally recognized that these items form the waste products of the electric light business, and in most cases a fairly low flat meter rate is adopted for electrical energy supplied for these purposes. Probably this is due to the fact that motor loads have to compete with gas, steam and hydraulic power, consequently the price to be charged for electricity for power purposes has to be fixed more by the charge made for gas, steam, etc., than by its relation to the total costs of production. The author gives the following as an example of the relative cost of gas and electricity for power purposes: a nine-horse-power gas engine, with gas at one shilling sixpence, cost from twenty-two to twenty-six shillings per week, including gas, interest, renewals, etc.; while a nine-horse-power single-phase motor which replaced the gas engine, with electricity at one and one-half pence per unit, cost fourteen to sixteen shillings per week.

If a central station could operate at an approximately constant load for twenty-four hours per day, the service would be an ideal one, and the commercial age of the electric light business would be realized. Then a uniform rate would be the ideal rate; but at present, a uniform rate for all purposes and at all times is not only impracticable, but unjust. A differential rate in some form, in the author's opinion, has certainly many points in its favor, and is the most workable system, provided the initial rate is not too high.

Spanish Hematite Ore for the United States.

A vein of hematite iron ore, rich in quality necessary for the making of red paint for structural ironwork, has been discovered near the city of Jaen, in the province of that name, which has been worked during the past year and much of the output has found ready sale in the United States. A reported marked decrease in the output of ore of this class in the United States has probably stimulated the interest of American paint manufacturers in the Malaga product—so much so, in fact, that an eastern state paint firm seriously contemplated the purchase of an interest in the mine. Failure to reach a satisfactory agreement with the local owners has, it appears, checked the deal. It seems hardly probable, however, that the original plan will be carried out. This contemplated the formation of an American corporation which would control the output of the mine. The present outlook is that this idea has been abandoned and that the matter will result only in an additional quantity of ore being supplied. The mine is 100 miles from Malaga, but the ore is brought here by rail and prepared for shipment, both in its crude state and refined, at a plant on the outskirts of this city.

The Tufts Engineer.

The January number of the *Tufts Engineer,* published by the engineering society of Tufts College, Massachusetts, contains an article by C. W. Bray, describing the engineering course at the college; a description of the pneumatic tubes in Boston, by E. D. Sabine; a discussion of the proposed improvement on the St. Charles river, by O. M. Moulton; an article on the inventions of Mr. Peter Cooper Hewitt, by A. P. Wills; an article on the work of the Metropolitan water and sewerage boards, by F. T. Daniels, and one on bridge and structural engineering, by E. H. Rockwell.

Report of the Congress of Houille Blanche (Water Power).

The complete transactions of the Congress of Houille Blanche, which was held at Grenoble, France, September 7 to 13, 1902, have been published. The transactions form two large octavo volumes of 600 and 660 pages, respectively, with many illustrations. These contain the papers and discussions on water power development and utilization, and descriptions of the visits made by the members. The price of these is thirty francs ($6), and they can be secured from the secretary of the Syndicat des Forces Hydrauliques, Chambre de Commerce, Grenoble.

SOME POSSIBILITIES OF THE ALTERNATING-CURRENT SINGLE-PHASE RAILWAY MOTOR.[1]

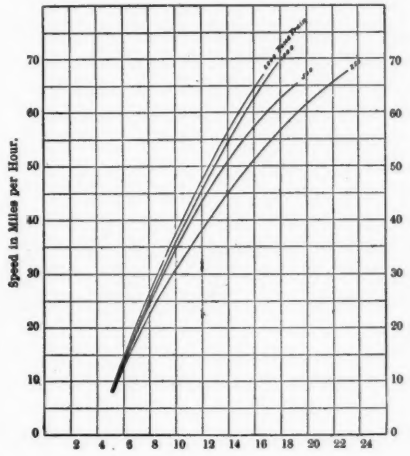
BY A. H. ARMSTRONG.

The electric railway motor has replaced the horse and cable on our city streets, the steam locomotive on overhead and underground rapid transit lines, and has conclusively proved its exclusive right to operate suburban cars over distances reaching more than fifty miles from the outskirts of larger cities. All this has been accomplished with the direct-current series motor operating at a potential approximating six hundred volts and with alternating-current distribution to suitably located rotary converter substations. There are isolated cases where the electric motor has replaced the steam locomotive on steam lines, and where this has been done the increase in the dividend earning power of the road has been sufficiently great to warrant the extension of the electric service and the changing over of more steam-operated lines. With the commercial development of the alternating-current railway motor, new possibilities are introduced in electric railroading, owing to the much higher voltages for which the motor itself can be wound, and due also to the fact that alternating current is used directly as motive power without the expensive transforming apparatus required for the direct-current series motor.

The alternating three-phase induction motor has been applied to traction work with doubtful success, owing to its practically synchronous characteristic, its limited output making it sensitive to the heavy voltage drops liable to occur in railway work, and due, furthermore, to the complication of double overhead trolley required for this type of motor.

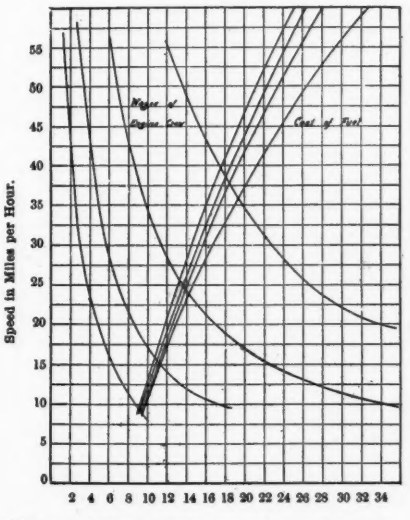
During the past few years there have been developed several types of single-phase alternating-current motors having speed-torque characteristics even better adapted for railway work than that of the direct-current series motor, and, furthermore, providing ample starting torque with any voltage variation liable to occur in practical electric railway operation. As these motors can be operated with a single trolley and ground return, and can, furthermore, be operated satisfactorily on either direct or alternating current, it makes their field of usefulness much greater than their direct-current series competitor.

Having such a motor with practically no restriction as to voltage, it is possible to break away from the exclusive field of electric traction with frequent service and small units and consider the operation of freight and passenger trains over our regular steam lines. In order to arrive at some general conclusions not limited by the local considerations of a specific case, this paper is devoted to a somewhat brief and general discussion of the operation of our steam lines by the alternating-current railway motor.



POUNDS PER TON. CURVE SHEET 1 TRAIN FRICTION CURVES.

To make the conclusions general, trains of different weight have been taken, operating at different speeds and varying headway over a level track. As being typical, train weights of 2,000, 1,000, 500 and 250 tons of 2,000 pounds have been selected. As the investigation of the operation of these trains will be carried to maximum speeds of sixty to seventy miles per hour, the total friction of the train expressed in pounds per ton is given in curve sheet 1. This friction is not that of the trailing load, but includes the running and wind friction of the locomotive itself.



COST PER 1,000 TON-MILES. CURVE SHEET 2—COST OF STEAM OPERATION, COAL $2 PER 2,240 POUNDS.

From a number of tests a steam consumption of approximately thirty pounds per indicated horse-power-hour is taken as the basis of all locomotive work. It is assumed that locomotives are compound, as this steam consumption could hardly be expected with simple engines under average conditions. To make all results comparable further assumptions are made of an evaporation of seven pounds of water per pound of coal, an engine efficiency of eighty-five per cent, and cost of coal at $2 per ton of 2,240 pounds. The price of fuel will vary and this is considered later. As we are figuring upon actual performance of the locomotive, that is work done in overcoming train friction, it will be necessary to introduce a factor allowing for coal wasted in making up and damping fires, and general waste incident to locomotive practice when standing idle for a large part of the twenty-four hours. Furthermore, a steam locomotive is called upon to operate throughout the year at varying temperatures of the surrounding air, and coal consumption during the winter months is in excess of that during the summer. This excess may reach twenty per cent as an average during the cold weather, and hence ten per cent additional fuel is charged to the locomotive for the work assumed, to take care of the different conditions of operation which the electric locomotive does not have to contend with.

On the basis of the above assumptions, all of which are the result of practical tests, curve sheet 2 is obtained.

These figures check up reasonably close with the locomotive performance sheets for steam roads after superfluous mileage has been deducted from the total mileage given. As an example the shifting locomotives and pushers are charged with so many miles per hour and often do not make one-third the mileage charged to them, so that locomotive performance sheets, as published, some times indicate too low a coal consumption per 1,000 ton-mile of actual work done.

The next item of considerable expense in steam operation is the labor account. As it is immaterial to the train crew whether steam or electric locomotives are supplied, this item will not be entered into. The engineer and fireman, however, are greatly influenced by the character of the motive power. In steam operation a crew working ten hours a day average for

[1] Read before the electrical section of the Canadian Society of Civil Engineers, November 19, 1903.

the railroad company will not be in actual service on the road more than forty or fifty per cent of the time, the remainder of the time being taken up in caring for the locomotive. In electrical operation the full time of the crew can be utilized for active duty, and hence a considerable saving effected in this item. In steam operation a crew costing $8.50 for ten hours' labor has been assumed to be in active commission for five hours per day, while in electric service the crew is assumed to be in commission 8.3 hours per day out of the ten. For shorter hours of labor the same proportion would hold true, and the crew for the electric locomotive will cost but sixty per cent of that for the steam locomotive. The cost of wages per 1,000 ton-mile is given in curve sheet 2.

In order to approximate the repairs on steam locomotives of different capacities, it is assumed that the locomotive will have its weight proportioned to the trains which it is to handle and as a basis of the repair item, the following values are assumed, agreeing closely with the results of compound locomotive in actual service.

STEAM OPERATION—REPAIRS, CENTS PER 1,000 TON-MILE.

Tons.	Cents.
250	25
500	13.8
1,000	7.7
2,000	3 3

The items of oil, waste and water are not determined here at length, but are introduced in the final values obtained for operating expense. Combining the figures obtained above for steam operation, including fuel at $2 per 2,240 pounds, engine crew at $8.50 per ten hours (five of which are in actual service), repairs; oil, waste, water, etc., the results in curve sheet 3 are obtained.

It is evident from the curves that each weight train can be run at a certain speed with a minimum expense for operation, this speed varying with the weight of the train. This economical speed will, of course, vary with any variation of the constants assumed above, such as the price of coal, labor, etc., but the values obtained are instructive and are given below:

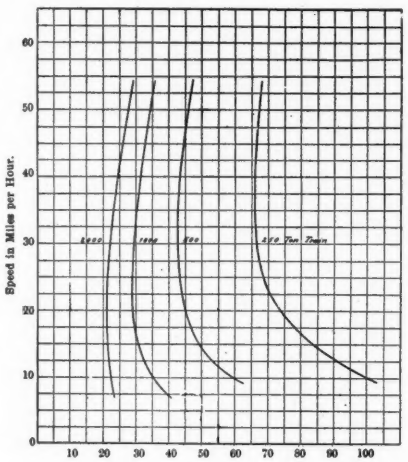
SPEEDS OF ECONOMICAL OPERATION.

Tons.	Miles per Hour.
250	38
500	28
1,000	23
2,000	19

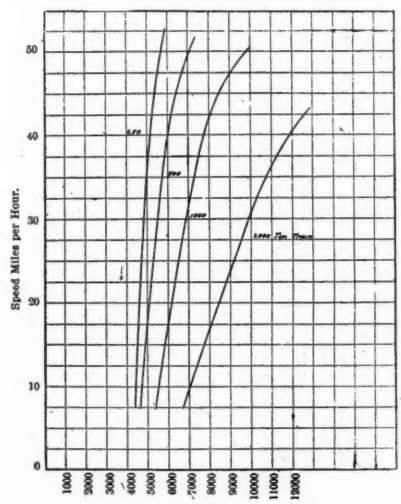
Considerable latitude is given above and below these speeds without greatly increasing expense per 1,000 ton-mile for operation.

Coming now to the determination of the cost of operating an electrically propelled train under the same conditions, we arrive at some very interesting results due to the low first cost of electrically equipping the proposed steam line afforded by the alternating-current single-phase motor.

The same friction values are used as given in curve sheet 1 for steam operation. From these values the kilowatt capacity of each train is determined for the different speeds and varying weights of trains. From these values the cost of



COST PER 1,000 TON-MILES. CURVE SHEET 3—COST OF STEAM OPERATION, COAL $2 PER 2,240 POUNDS.



COST PER MILE SINGLE TRACK. CURVE SHEET 4—COST OF ELECTRICAL INSTALLATION, TEN TRAINS EACH WAY PER DAY.

trolley copper, step-down line transformers and generating station are determined. The electrical system consists, in brief, of a generating station controlling one hundred miles of track, that is, feeding fifty miles in either direction. At intervals of approximately twelve miles are installed step-down transformers reducing the transmission potential to 3,000 volts or more for the trolley potential. This trolley potential is assumed at 3,000 volts for a good majority of the results, but for heavy work, that is 1,000 and 2,000 ton-miles, the voltage is somewhat increased, but nowhere exceeds a safe operating value. The transmission potentials also are kept entirely within practical limits. The generating station does not get excessively large and the electrical system throughout presents no features of unusual interest, but rather duplicates work that is being done throughout the country. By keeping all values within conservative limits, the results obtained become of practical application and not of theoretical interest.

The cost of installing the electric system complete, including generating station, transformer substations, transmission line, poles, bonding of track, etc., is given in the following table:

COST OF ELECTRICAL INSTALLATION—COST PER MILE SINGLE TRACK.

Miles per Hour.	5 Trains Each Way.	10 Trains Each Way.	20 Trains Each Way.
2,000-TON TRAIN.			
10	5,600	7,020	9,860
20	6,520	8,490	12,430
30	8,510	9,840	14,580
40	11,690	11,910	16,770
1,000-TON TRAIN.			
10	4 800	5,500	6,920
20	5,200	6,200	8,100
30	6,250	6,900	9,400
40	7,600	7,700	10,600
50	9,820	9,820	12,700
500-TON TRAIN.			
10	4,400	4,700	5,400
20	4,500	5,100	6,000
30	5,100	5,500	6,800
40	5,900	6,000	7,500
50	7,100	7,100	8,600
250-TON TRAIN.			
10	4,200	4,400	4,800
20	4,300	4,600	5,000
30	4,600	4,800	5,400
40	5,100	5,200	6,000
50	5,700	5,700	6,600

The above tables are given at length as they form very interesting reading, showing how the cost increases with the size of the unit rather than by the frequency of the trains. Also it is very necessary to arrive at an initial cost of electrical installation somewhat accurately as this constitutes a funded debt upon which the saving, if any, between electrical and steam operation must pay dividends.

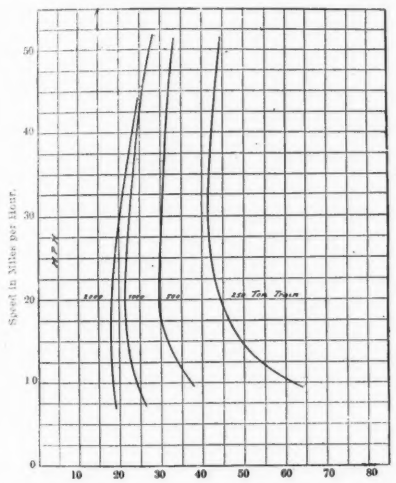
In determining the cost of electrical operation it has been necessary to consider the cost of producing power, and a sliding scale has been taken for the different kilowatt outputs, ranging from four mills per kilowatt-hour to nine or more, with coal at $2 per ton, depending upon the kilowatt capacity of the generating station. It is assumed that steam

turbines and modern methods of generating station construction are used, looking to the greatest economy of operation. Wages of engine crew, as stated, are taken at sixty per cent of those for steam operation. Repairs for electrical locomotives are given in the following table:

ELECTRICAL LOCOMOTIVE REPAIRS.

Tons.	Cents per 1,000 Ton-Mile
250	8
500	4.8
1,000	2.3
2,000	1

These repairs, in common with that given for steam operation, include all running repairs, overhauling and renewals. The cost of electrical operation is given complete in curve sheet 5, which



CURVE SHEET 5.—COST OF ELECTRICAL OPERATION, COAL $2 PER 2,240 POUNDS.

are directly comparable to the cost of operation for steam previously given. It is obvious that as there is a fixed charge of five per cent depreciation and repair account on the entire electrical installation, it is necessary to consider the frequency of travel over our proposed route. In order to make it as general as possible, it has been assumed that there will be five, ten and twenty trains per day each way. The cost of operation expressed in cents per 1,000 ton-mile does not vary greatly with the different frequency of trains, but the dividend account must be based upon a selected train frequency. For convenience, a train frequency of ten per day each way is taken, and the cost of electrical operation given. For other frequency of trains, the cost of operation per 1,000 ton-mile will not vary more than one or two cents either way from the results given in the curves and they are, therefore, of fairly general application.

By comparing this curve with that given for steam operation, a considerable saving is shown, giving varying dividends depending upon the frequency of travel, weight of train, maximum speed, etc. In fact, frequency of travel and weight of train are the determining features in considering the adoption of electric transportation. In order to show the dividend earning power—that is, the saving in electric operation over steam as the percentage of the cost for electrical installation—the three following tables have been prepared for a frequency of train service of five, ten and twenty trains each way per day.

INTEREST ON ELECTRICAL INVESTMENT.

FIVE TRAINS PER DAY EACH WAY.

Miles per Hour.	2,000 Tons.	1,000 Tons.	500 Tons.	250 Tons.
10	5.75%	8.17%	9.25%	9.22%
20	3.88	4.92	5.73	6.02
30	1.81	3.82	4.1	4.85
40	....	3.47	3.68	4.07
50	....	....	3.36	3.74

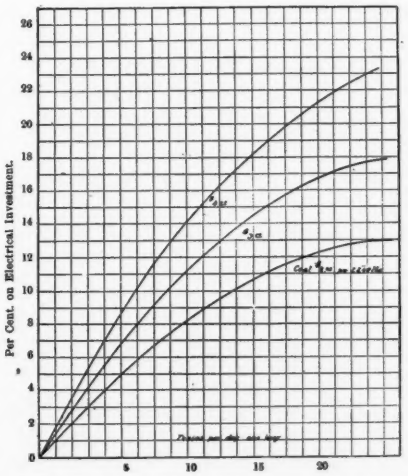
TEN TRAINS PER DAY EACH WAY.

10	8.48%	14.8%	17.5%	18.3%
20	4.68	8.87	11.05	11.9
30	1.31	7.2	8.1	9.65
40	....	6.8	7.62	8.14
50	....	....	6.72	7.48

TWENTY TRAINS PER DAY EACH WAY.

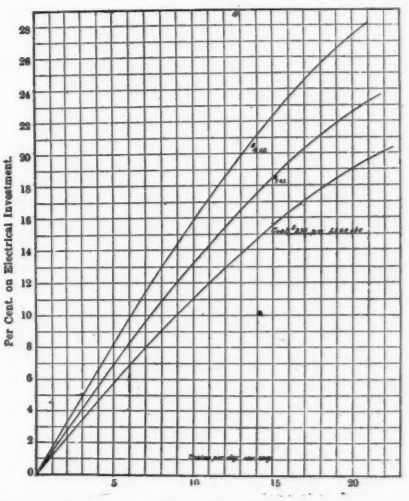
10	8.92%	23.1%	31.4%	34.5%
20	2.6	12.9	19.1	22.1
30	....	9.8	13.65	17.8
40	....	9.73	12.8	15.0
50	....	....	11.25	13.7

As shown by the above tables, electric locomotives can not compete with steam for trains of 2,000 tons at higher speeds, owing to the enormous cost of equipping the road electrically with the constants chosen. Should such heavy railroading be contemplated electrically, it would be necessary to adopt longer transmissions than the fifty miles either way from the power-



CURVE SHEET 6.—NET EARNINGS ELECTRICAL INSTALLATION, 1,000-TON-TRAIN UNITS.

house assumed, and which is very conservative, also the use of higher voltages on the trolley than the 5,000 or 6,000 volts maximum assumed in arriving at the tables. The scope of the paper has been limited, however, to the use of standard apparatus and voltages met with in every-day practice. The results given thus represent the practice of to-day and not what electrical engineers may be able to do some time in the future. The consideration of the operation of 2,000-ton trains at speeds of fifty or sixty miles per hour is hypothetical, as no steam locomotive could be constructed that would furnish sufficient power to haul a train of this weight at the speeds considered. The problem is feasible from an electrical standpoint as the weight of the locomotive could be distributed among a number of units distributed throughout the train to



CURVE SHEET 7.—NET EARNINGS ELECTRICAL INSTALLATION, 500-TON-TRAIN UNITS.

lessen the draw-bar pull without exceeding a permissible weight per axle.

The discussion of the paper has been limited thus far to the use of coal costing $2 per ton for both steam and electric locomotive work. It is a well-known fact that generating stations can use cheaper coal than it is economical to use on steam locomotives, and hence it is interesting to follow through the results with varying prices of coal. In figuring the cost of coal, it is assumed that coal will be charged to operation at the price for which it could be sold in the wholesale market at the locality used. Coal at $2 per ton is somewhat cheap, especially for some of the western roads, and the same method of figuring has been used in determining the earning capacity of the electrical installation for $3 and $4 coal as well. As the saving in electrical operation and its percentage of the cost of installing the electrical system are of fundamental importance, the tables for interest-earning capacity expressed as percentage of the elec-

trical installation is given in the following tables both for $3 and $4 coal.

COAL AT $3 PER 2,240 POUNDS—INTEREST ON ELECTRICAL INVESTMENT.

FIVE TRAINS PER DAY EACH WAY.

Miles per Hour.	2,000 Tons.	1,000 Tons.	500 Tons.	250 Tons.
10	8.35%	10.6%	10.8%	9.6%
20	6.77	6.8	6.9	6.4
30	4.35	5.8	4.85	5.02
40	8.12	5.5	4.94	5.0
50	....	....	4.7	4.67

TEN TRAINS PER DAY EACH WAY.

10	12.8%	17.7%	19.5%	19.4%
20	8.77	12.1	13.2	13.
30	7.3	10.75	10.	11.1
40	6.	10.75	10.47	10.3
50	....	....	9.4	9.34

TWENTY TRAINS PER DAY EACH WAY.

10	14.9%	27.8%	38.4%	36.3%
20	8.2	17.7	22.6	23.8
30	7.9	15.	17.	20.1
40	6.25	15.2	17.3	18.1
50	....	....	20.4	16.9

COAL AT $4 PER 2,240 POUNDS—INTEREST ON ELECTRICAL INVESTMENT.

FIVE TRAINS PER DAY EACH WAY.

Miles per Hour.	2,000 Tons.	1,000 Tons.	500 Tons.	250 Tons.
10	11.0%	11.65%	11.6%	10.2%
20	9.65	8.65	8.15	7.19
30	7.04	7.74	6.35	5.72
40	5.64	7.54	6.2	5.75
50	....	....	6.13	5.6

TEN TRAINS PER DAY EACH WAY.

10	16.8%	20.8%	21.4%	20.4%
20	13.4	15.2	15.8	14.7
30	12.0	14.3	12.2	12.7
40	10.72	15.	12.8	11.8
50	....	....	12.2	11.2

TWENTY TRAINS PER DAY EACH WAY.

10	21.1%	33.2%	38.4%	38.0%
20	14.8	22.9	27.4	25.6
30	16.8	20.3	20.3	22.6
40	12.4	20.9	21.1	20.7
50	....	....	20.4	20.1

A study of the above tables brings out the fact that for very infrequent service, that is five trains per day each way or less, it would hardly pay to equip the road electrically, there being a dividend of from four to seven per cent on the capital invested. With more frequent service, however, the saving in electrical operation becomes more marked until at from fifteen to twenty trains per day each way, the interest earning power of the electrical investment is worthy of very careful consideration. It should be borne in mind that all these figures do not contemplate increase in the present traffic of the road, and, therefore, do not take into consideration one of the chief characteristics of electric traction, that is developing short haul local traffic and thus increasing the dividends by increasing the receipts rather than by cutting down operating expenses. The well-known ability of electric roads to greatly increase previous steam traffic has led them to be installed, in many cases, without too close an investigation into their economical installation. Taking into account therefore that the electrically equipped road, while caring for the heavy through freight traffic with an earning capacity of from four to seven per cent on the investment, can also build up a local traffic both freight and passenger, with practically no additional cost and showing very large returns.

Taking up the possibilities of the alternating motor in general haul work, the problem had to be treated in a very general way in order not to lose sight of the scope of the problem in considering local details. The average specific problem has its local conditions, which must be carefully considered in detail, and, in many cases, would show a greater return for the money invested than indicated in this paper. For instance, all power is supposed to be generated from coal from power-house devoted to the interests of railroading alone. Along many of our roads exist water power facilities which could be advantageously developed and furnish power much cheaper than the figures assumed from coal generation. Furthermore, the cost of power in the smaller generating station capacity has been assumed as high as one cent per kilowatt-hour or more, and should a generating station supply other industries, such as mining, lighting, general power distribution, etc., the cost of purchasing power would be considerably decreased with a consequent reduction in cost of operating electrically. The results given in the table therefore are of general application only and may be considerably modified when considering the local aspect of a given proposition. It is believed, however, that the results as obtained are based upon conservative assumptions, in fact, most of these assumptions were obtained from operating conditions, and, with the figures given, outline somewhat briefly the possibilities of the alternating-current single-phase motor in the railway field.

The operating expenses considered include fuel, wages, repairs, oil, waste, and five per cent depreciation of the electrical installation. No depreciation is charged off against the locomotives, as although the electric locomotives cost more than the steam, they will permit of a greater mileage, so that the total capital invested in locomotives should be practically the same in either case. There are a number of expenses incidental to steam operation other than those considered which must be done away with with the adoption of the electric locomotive. While each of these expenses is small they may amount to considerable in the aggregate. For example, the electric locomotive is double ended and requires no turntable. Two electric locomotives can be coupled together and operated by one engineer in the cab on the leading locomotive, each locomotive doing an equal share in hauling the train. In fact, it is not strictly necessary to consider the use of a fireman in electric propulsion, as his duties will be largely confined to ringing the bell, and waiting for the engineer to die of heart disease. His services can be dispensed with entirely if we consider that the electric locomotive cab can be made the caboose for the train, and the train crew serve as a reserve for the engineer in case of trouble. The cost of fuel has been assumed equal in both cases, but there is an added expense in handling the fuel for steam operation as the source of supply of the locomotives is distributed in small pockets over considerable track, each pocket requiring more or less outlay for its establishment and maintenance, all of which can be saved by electric locomotive fed from a central generating station. The increasing tendency toward the adoption of very heavy trains calls for heavier locomotives with consequent increase in weight of rail, cost of bridges, ballasting track, and general maintenance of the right of way. Indeed, the wear upon a light rail with a heavy reciprocating engine must be considerably more than that given to the rail by an electric locomotive of half the weight and having a perfectly uniform rotary impulse imparted to the drivers. Just how much money may be saved by the lessened maintenance of the track is conjectural and hence has not been entered into here, but the figure must reach a considerable size for heavy locomotive work. As the maintenance of electric locomotives is considerably less than its steam competitor it will reduce the size of repair shops required, the difference in the interest on which should appear as a fixed charge against steam operation. Furthermore, a steam locomotive including a tender has not more than fifty per cent of its weight upon the drivers, which will constitute from seven to ten per cent of the average train weight. As this is a dead weight, producing no revenue, it would be fair to compare the two systems by estimating upon a train for steam operation from seven to ten per cent heavier than for electric operation. The comparative figures given in the table based upon 1,000 ton-miles are not, therefore, entirely fair toward electric operation, but should be somewhat increased for haulage involving the use of the steam locomotive.

The earning capacity of the money invested in electric equipment can be looked upon, therefore, as exceeding the values given in the tables, but as stated above, local conditions will largely affect the application of the general figures to any given example. Should all the factors entering into the engineering expense of operating roads by steam and by electric locomotives be carefully considered, the possibilities opened up by the use of the alternating motor are sufficiently great to warrant its replacing the steam locomotive in many of our railway systems, either in part or for the complete system.

The American Association for the Advancement of Science.

The fifty-third annual meeting of the American Association for the Advancement of Science was held in St. Louis, Mo., convening on December 28 last. The meeting was under the presidency of the Hon. Carroll D. Wright. After the address of welcome the convention broke up into the various sections and received the addresses of the retiring vice-presidents.

The retiring vice-president of the section on physics, Professor E. F. Nichols, was not present, and Section B was united with Section D, mechanical engineering, and was addressed by Professor C. A. Waldo, of Purdue University. The subject of Professor Waldo's address was "The Relation of Higher Mathematics to Engineering." President Ira Remsen, of Johns Hopkins University, the retiring executive of the association, addressed the session on "Scientific Investigation and Progress."

On the following four days the sections took up the regular work of the reading of technical and scientific papers. There were a number of papers read before the mechanical engineering section, of more or less interest to electrical engineers.

The section of physics, presided over by Professor E. H. Hall, of Harvard University, listened to thirty-seven papers, a number of which concerned electrical subjects. The following may be mentioned as among the more interesting: "Iron Losses in Loaded Transformers," by Professor E. S. Johonnott, of Rose Polytechnic Institute; "A Simple Alternate-Current Frequency Recorder," by Professor E. S. Johonnott; "On the Velocity of Light in a Magnetic Field," by John Mills, of Western Reserve University; "A Method for the Determination of Mutual Induction Coefficients," by Augustus Trowbridge; "On the Electrical Resistance of Hydrogen-Charged Palladium," Professor W. E. McElfresh, of Williams College; "On the Use of Nickel in the Case of the Marconi Magnetic Detector," by Professor Arthur L. Foley; "On the Charges Given to Surfaces by the Diffusion of Ions and the Earth's Negative Potential," by Professor John Zeleny, of the University of Minnesota; "On the Differential Telephone," by Professor William Duane, of the University of Colorado; "A Continuous Method of Steam Calorimetry," by Dr. Joseph H. Hart, of the University of Pennsylvania; "Radium and Radioactivity," by Professor E. Rutherford, of McGill University.

Twelve papers were read before the American Physical Society, which held its annual meeting in connection with the association. Professor A. G. Webster, of Clark University, was reelected president for the coming year.

Philadelphia, Pa., will be the headquarters for the next meeting of the association, the convocation beginning December 28, 1904.

Annual Dinner of the American Institute of Electrical Engineers.

On Monday, January 11, the committee in charge of arrangements for the annual dinner of the American Institute of Electrical Engineers held a meeting at the Arkwright Club, New York city, at which time the committee was the guest of Mr. R. R. Bowker.

This meeting was for the purpose of formulating plans for the carrying out of the several features which will make this annual dinner a particularly notable event in the history of electrical engineering. Those present were Mr. Calvin W. Rice, chairman; Mr. Arthur Williams, Mr. T. C. Martin, Mr. Charles W. Price, Mr. B. Gherardi, Jr., Mr. R. R. Bowker and Lieutenant F. J. Sprague.

The annual dinner will be held in the grand ballroom of the Waldorf-Astoria, New York city, on February 11, at seven P. M., and will be commemorative of the birthday of Thomas A. Edison, who will be the guest of honor. It is expected that some 500 will be seated in parties of six or eight. The price of tickets for the dinner will be $7 per plate for gentlemen and $5 per plate for ladies. The speeches will be opened by the president of the Institute, Mr. B. J. Arnold, to be followed by Mr. T. C. Martin as toastmaster. Mr. Samuel Insull, chairman of the Edison Medal Association, will be called upon to state the object of this organization. In connection with this arrangement the Edison Medal Association has issued the following circular:

In view of the fact that the year 1904 marks the twenty-fifth anniversary of the successful introduction and commercial development of the incandescent lamp, it is deemed appropriate to celebrate so significant an occasion. The friends and associates of Thomas Alva Edison, the pioneer with whose work this great event in electrical history is so closely identified, desire, therefore, to pay him some timely tribute in recognition of what he has thus contributed, as well as in other respects by notable inventions and by unremitting effort, to the advance of electrical science, application and industry. No other twenty-five years in history have equaled this period in the benefits bestowed on mankind by the electrical arts, or in the profitable employment given to capital and labor.

The means proposed for signalizing the anniversary are the foundation and endowment of an Edison medal, whose award shall stimulate the ambitions and energies of young men proposing to devote themselves to electrical careers. It is intended that this medal shall go each year to that student in electrical engineering whose thesis or recorded research shall be deemed most worthy of honor.

The American Institute of Electrical Engineers has agreed to act as the trustee for this medal, and the plan is to have the various colleges and universities of the United States and Canada in which the degree of electrical engineering is given, select in each instance the best thesis presented by their respective graduates for the year, which thesis shall be sent to the proper committee of the American Institute of Electrical Engineers; and that committee will make the final selection. The governing conditions will be announced later and will be embodied in the deed of gift. Not only will the name of Edison be appropriately distinguished, but a decided incentive will be given to the young engineer toward original effort.

It is proposed to raise the sum of, say, approximately $7,000, of which $5,000 will represent the principal, the interest on which shall be applied to this purpose annually. It is expected that those who are invited to subscribe will do so in sums ranging from $10 or less, up to such amounts as are in accordance with the sentiments of the contributor and his desire to accomplish the admirable purpose and object in view, as representative of a great period of development in which he has played a part.

You are requested to send your subscription at once to Frank S. Hastings, treasurer, 80 Broadway, New York, N. Y. You are also requested to forward to any member of the executive committee the names of any gentlemen whom you consider entitled to an invitation to contribute to the fund. It is proposed to present this medal fund to the Institute, as the trustee, with the names of the contributors, at the annual dinner of the American Institute of Electrical Engineers, with Mr. Edison as a guest of honor, February 11, 1904, and it is therefore proposed that subscriptions shall be closed February 1.

The officers of the Edison Medal Association are: Samuel Insull, chairman, Edison Building, Chicago, Ill.; Charles Batchelor, vice-chairman, 33 West Twenty-fifth street, New York city; Frank S. Hastings, treasurer, 80 Broadway, New York city; Robert T. E. Lozier, secretary, 774 Ridgeway avenue, Cincinnati, Ohio, and 220 Broadway, New York city.

Invitations will be sent to the presidents of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers and to a number of prominent members of technical and allied engineering interests. Heads of colleges will be invited and financial interests will probably be represented.

The following preliminary appointments have been made: "Committee on Menu," Mr. T. C. Martin; "Committee on Tickets, Their Issuing and Seating Arrangements," Mr. C. F. Bates and Mr. Calvert Townley; "Committee on Decorations," Mr. Arthur Williams; "Committee on Invitations and General Committee to Look After the Comfort of the Guests," Mr. Charles W. Price, chairman; Mr. E. H. Mullin, Mr. Bancroft Gherardi, Jr., and Mr. William J. Hammer.

Reviews of Current Engineering and Scientific Literature.

A Search for the N-Rays of M. Blondlot.

M. Blondlot, who announced the discovery of the N-rays, says that they are very easily obtained. Herr H. Zahn has, however, made a careful search for the effects described, but has not been able to detect them. He here describes the apparatus used, and he believes that it is far more sensitive than that used by Blondlot. Herr Zahn caused the rays given out by an Auer burner to pass through a concentrating lens of quartz, and then to fall upon a small sensitive flame. A suitable screen, placed around this flame, cut off all other radiation, while a sliding screen could be interposed between the sensitive flame and the source of the N-rays. To detect any variation in luminosity of the sensitive flame, a selenium cell, connected to a galvanometer, was set up close to the flame. All the apparatus was arranged with the greatest care, and all screens were covered with lead-foil; but the author was unable to detect at any time any change in the resistance of the selenium cell, whether the rays from the Auer burner were allowed to fall upon it or not. He also used, in another experiment, a very small electric spark, which was adjustable by means of the liquid resistance placed in parallel, but this gave only negative results. He does not in any way question Blondlot's work, but he thinks that the latter has underestimated the difficulty of obtaining N-rays.—*Translated and abstracted from the Physikalische Zeitschrift* (*Liepsic*), *December* 15.

The Commercial Side of Engineering.

In this article Mr. Walter M. McFarland emphasizes certain phases of the commercial side of engineering which are often neglected. It is frequently said that "the best is good enough for us," but the author believes that this saying should be reversed and, with reasonable limitations, we should say, "good enough is best." He backs up his opinion by reference to several notable engineering works in which simple, but crude, methods of operation were adopted, but which worked with entire satisfaction. In some cases, in a later structure patterned after the first, what was thought to be an improved method was adopted; but the latter proved to be too delicate for the work required of it. In many cases, where the most economical machinery has been put in, it has been found later that the interest on the increased cost over a simpler plant, and the additional cost for repairs, are not equaled by the saving in fuel. An engineer, when scheming his general plan of machinery, ought to make up statements which will include not only the cost of fuel, but the interest on first cost and allowance for depreciation, repairs, etc. The machinery which represents the lowest aggregate of these annual costs is that which it is best to use. Probably in almost every case of the use of electricity, the commercial aspect demands careful consideration. This is for the reason that, speaking broadly, electricity, as such, can not be stored. The result of this is that the capacity of the station must, in general, be great enough to answer the maximum demand upon it. It pays the station to sell current to a customer who furnishes a steady load at more liberal figures than to the one whose load varies. Another feature of this age of close economies is the manufacture of articles in standard sizes and strictly to gauge. While a standard machine may not, in itself, seem that best adapted to a particular case, in almost all cases it will be found that the saving effected by the design of a special machine for a particular case will not be sufficient to warrant the increased cost of such machine. Careful attention should be paid to the great benefit and strength in the work of design which comes from an intimate knowledge of shop processes; and the organization of a shop should be such that as little clerical work as possible is thrown upon foremen and the other high-salaried officers, as this work can be done just as well by boys, leaving the foreman as much of his time as possible for actual production.—*Abstracted from Cassier's Magazine* (*New York*), *January.*

Water Softening.

An enquiry into the working of various water softeners has been made by Messrs. C. E. Stromeyer and W. B. Baron, who have given their conclusions in a paper before the British Institution of Mechanical Engineers. They find that a thin coating of scale on the boilers reduces the efficiency but slightly; a coating of one-eighth of an inch, under normal operating conditions, decreasing the efficiency but a few per cent; but the scale prevents the water from coming in contact with the boiler plates. Thus, the plates of a boiler operating without scale will have a temperature on an average about twenty degrees Fahrenheit higher than that of the water, while a coating of one-eighth of an inch of the scale may make a difference of nearly 300 degrees. This has the effect of weakening the plates, making them liable to collapse, and causes severe contraction to take place whenever the furnace door is opened. The authors estimate that the strain thrown on a boiler when the door is open, under the conditions cited, would be one and one-half tons for a boiler free from scale, and twenty-two tons for a boiler having one-eighth inch of scale. The behavior and methods of removing the various impurities contained in water are summarized as follows: carbonate of lime forms hard scales in economizers, and a soft mud in boilers, unless sulphate of lime is present, when it is also cemented into a scale. Carbonate of lime can be removed by boiling or by adding enough caustic lime or caustic soda to combine with the free and half-bound carbonic acid which holds it in solution. If caustic soda is used, it must be added to the water before. Sulphate of lime forms no scale in economizer pipes, but forms a very hard scale in boilers. Its deposition is due to slow concentration of the water, but it can be entirely removed by adding carbonate of soda, which converts it into carbonate of lime. Carbonate of magnesia generally behaves like carbonate of lime, except that it is slightly more soluble. The other salts of magnesia are very soluble, and as they seem to cause corrosion should be removed, which can be done by adding carbonate of soda. In any case, chemical treatment is necessary, as it is impossible to remove the salts by means of filters. Deposits of grease in boilers have the peculiarity that their effect is out of all proportion to their thicknesses. As grease offers ten times more resistance to the flow of heat than scale, one would expect that one-eightieth of an inch of grease would have the same effect as one-eighth of an inch of scale; but experience shows that the merest trace of grease—less than one-thousandth of an inch—can cause far more serious injury than scale. It is highly desirable to remove every trace of grease, and this can not be done by filters and grease separators. The only effective method of do-

ing this is to add mineral matter in solution to the water, and then to cause precipitation by chemical means. The grease adheres to the precipitate and can easily be removed by settlement or filtration. One difficulty in all water-softening plants is that of getting rid of the precipitate. This is usually so extremely fine that it can not be removed by filters, and must be allowed to settle. In some cases the filtrate is gelatinous and can only be precipitated by heating; and, in any case, large settling tanks are necessary. The paper then describes the systems of treatment used in seventeen different water-softening apparatus, giving details of construction.—*Abstracted from Engineering (London), December 25.*

Differential or Localized Electroplating.

It is often desirable in plating one metal with another to secure a thicker coating on one part than another. Various methods of accomplishing this are here described by Mr. Sherrard Cowper-Coles. The earlier methods consisted in the use of the so-called "doctor," a small plate of the metal to be deposited, wrapped about with some absorbent material. This doctor was connected to the positive pole of the plating battery; the article to be coated to the negative pole, and the process then consisted in dipping the doctor in the plating solution and stroking or rubbing the place to be coated. This process required some skill and took time. An improved method, due to Oetzmann, consisted in protecting those portions where the plating was to be thin with a non-conducting varnish. The exposed part was then plated to the desired thickness, and after removing the varnish the whole article was plated uniformly. Buck's system consists in arranging the anodes and work so that those portions where the thickest plating was to be deposited were nearest to the anode. The author has devised a method of plating spoons, forks and similar articles, the thickness of the silver-plating depending on the amount of wear on the different parts. The articles are adjusted in a rocking bar, placed above the solution, and the plating solution is kept flowing into and out of the vat. As the work proceeds, the level of the electrolyte is gradually lowered by means of an adjustable siphon, in order to prevent the formation of an unsightly line of demarcation between the thick and thin portions of the deposited metal. The electrolyte is freely agitated, and the anode is placed preferably in a horizontal position near the bottom of the bath. In Boyle's method, the plating is accomplished by means of an electric spark. The source of current is connected to a fixed terminal, on which the article to be plated is fixed. The other pole is connected through an electromagnet which attracts a spring which carries a point made of the plating metal. This point is moved over the surface where a coating is desired—*Abstracted from the Electrochemist and Metallurgist (London), December.*

Homes of the Engineering Societies.

In this article Mr. Henry Harrison Supplee gives brief historical sketches of the great engineering societies of the world, and describes their homes. The first of the great engineering societies to be founded was the British Institution of Civil Engineers, which was organized in 1818. This institution, after occupying rooms for some years, in 1838 acquired the site of the present handsome house. Several houses have been erected on this site, the present one being an entirely new structure started in 1894. It is situated at 25 Great George street, Westminster. The building cost about $250,000, and the site is valued at as much again. It contains a fine theatre, ample room for the library, and offices for the officers. The house is handsomely furnished and contains a library of 55,000 volumes and 15,000 pamphlets, making probably the most complete general engineering library in existence. The British Institution of Mechanical Engineers owns a house at Storey's Gate, St. James' Park, Westminster, within a stone's throw of the home of the civil engineers. It has occupied this building since 1899. The main hall is ingeniously provided with a floor built up of movable platforms or boxes, which, when uniformly distributed, provide a level floor flush with the vestibule without, while, by a suitable arrangement, they may be built up into a series of terraces for conversion into an auditorium. The reception room is handsomely decorated with fine, rare marbles. The Société des Ingenieurs Civils de France, Paris, was organized in 1848. After occupying several buildings, the present one was erected in 1897. This is a handsome structure, giving excellent examples of the manner in which constructive features can be artistically treated without concealment. The large reception room is converted into a meeting hall by lowering the floor, which is hinged at the back by means of winches, which mechanism works well in practice. The ground floor, in addition to this large room and annexes, has the entrance vestibule and lobby. The floors above contain rooms for conducting the business of the society, and the residence of the secretary. The Verein Deutscher Ingenieure, of Berlin, differs materially in its methods of work from the other national engineering societies. While it has a membership of 17,000, much of the work is carried on at the forty-two local sections scattered throughout all parts of the empire. For this reason the home of the society is not large. Much of the space there is devoted to editorial work, as the society publishes a weekly periodical which is one of the most complete and valuable engineering periodicals to be found in any country. On the main floor is situated a meeting room of ample size for the needs of the Berlin section, and the rooms for the officers' meetings. The basement and ground floor are rented for business purposes. The third floor is devoted to the editorial rooms, and above are the reading and drawing-rooms and the photographic studio. A short description is also given of the home of the American Society of Civil Engineers, New York city.—*Abstracted from the Engineering Magazine (New York), January.*

International Electrical Congress of St. Louis.

The State Department at Washington, in response to solicitations from the director of congresses at St. Louis and the president of the American Institute of Electrical Engineers, as well as the Committee of Organization of the Congress, issued instructions on December 17 to the American diplomatic officers abroad that they shall invite the various foreign governments to appoint official delegates to the International Electrical Congress of St. Louis in September, 1904. The number of delegates requested to be appointed by each country is in conformity with the precedents established at the Chicago Congress of 1903, and at the Paris Congress of 1900.

The Physico-Chemical Review.

The first issue of the *Physico-Chemical Review*, edited by Dr. Max Rudolphi, and published by Gebrüder Borntraeger, SW 11 Dessauerstrasse 29, Berlin, has come to hand. The aim of the publishers will be to make this journal a comprehensive centralizing review of progress in physical chemistry. It is intended to give abstracts of all important papers on this subject. As the journal will be international, these abstracts will be published in English and French, as well as German. The paper will appear twice a month, and specimen copies will be sent post free to all interested.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Burger Gas Engines.

The Wooley Foundry and Machine Works, Anderson, Ind., is the manufacturer of the Burger gas and gasoline engines shown in the accompanying illustrations. The design is such as to make the construction heavy and strong, and the journal boxes are given increased length to ensure accurate wearing and longevity. The bed is of the box type, and has two bored bearings, as well as having the end faced to receive the cylinder. The engine is mounted on an iron subbase. The cylinder is water-jacketed, and fitted to the base of the bed, having a flange by which it is secured to the bed by studs.

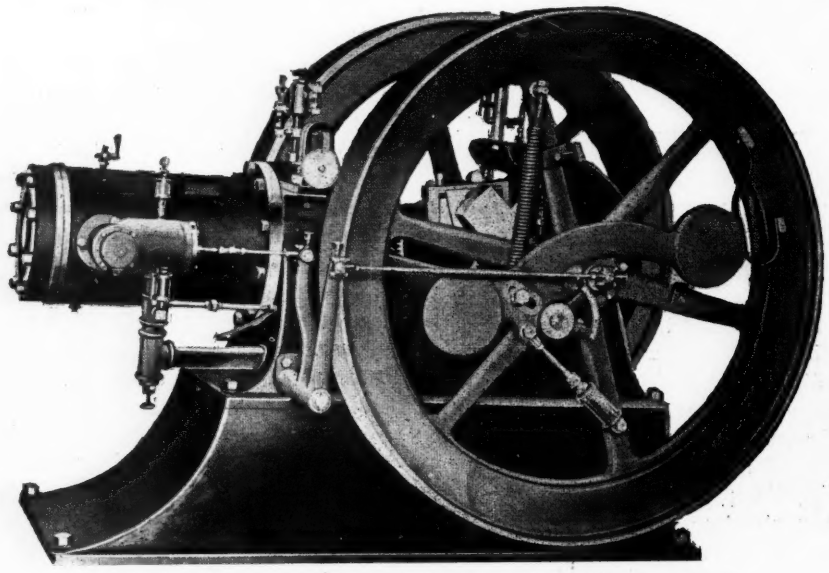


FIG. 1.– GAS ENGINE, WITH OUTSIDE AUTOMATIC GOVERNOR CONNECTION.

The igniter is a removable plug fitted to a hole communicating to the upper part of the cylinder (where the richest gases locate), ensuring perfect ignition. The plug is seated at its inner end, which is the only part exposed to the fire, thus keeping the body cool. This igniter has only one removable part. The current for the igniter is furnished by a magneto attached to engine bed and is driven from flywheel by a leather friction wheel.

The hit-and-miss type of engine is equipped with a centrifugal governor in connection with a sensitive valve.

The automatic type engine is equipped with a Rites's inertia governor of the single weight or inertia type. The principles of inertia and centrifugal force are combined in such proportions that the engine is held to a uniform speed against all disturbing influences caused by a sudden change in the load, and will act in an instant.

The piston is of the trunk pattern, extra long, having a long bearing in the cylinder. The crank-shaft is forged from a solid billet of steel, well turned and highly polished.

The connecting rod is of the box type. The bearings are adjusted by a wedge. The flywheels are especially heavy and perfectly balanced. Each flywheel is turned crowning so that either may be used as a driver.

The exhaust valve is of the poppet type, opened by a cam in direct movement of the valve.

FIG. 2.—CRANK-SHAFT OF AUTOMATIC GAS ENGINE.

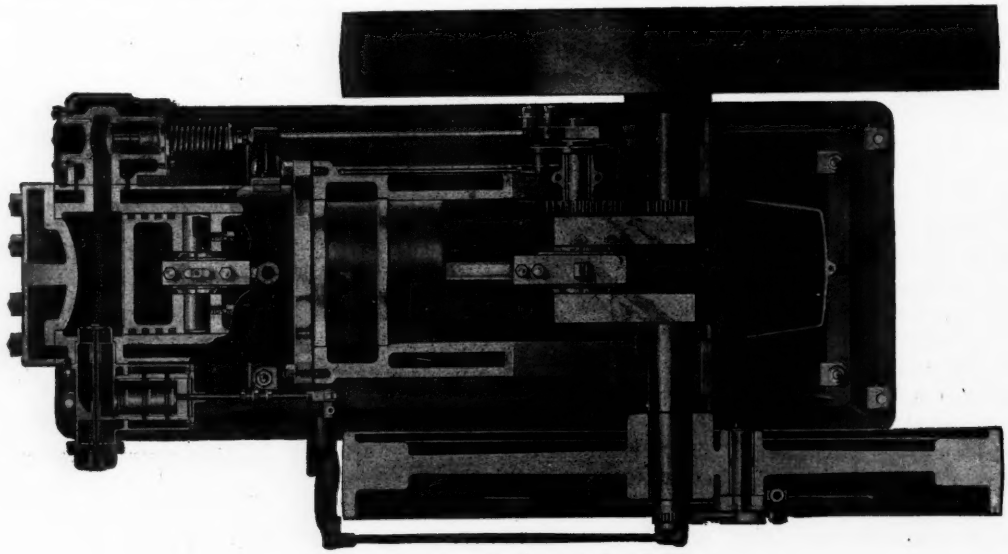


FIG. 3.—SECTION OF AUTOMATIC GAS ENGINE.

Fig. 1 shows the Burger automatic gas engine, with outside governor connection. Fig. 2 shows the crank-shaft.

Fig. 3 shows the Burger automatic engine in section. Referring to this illustration, the governor valve is cylindrical, having ports which cover like openings in its case. The two ports to the right are air ports (there are eight ports for air and two for gas). The third port, or the one to the left, is the gas port. The inlet valve protrudes into the cylinder, carrying the gas valve on the outer end of its stem. On the suction stroke the inlet valve opens, carrying with it the gas valve, permitting the gas to pass from the outer chamber to the inner and through the ports in the cylindrical valve and into the cylinder. The amount of air and gas which will pass through the ports is determined by the length of time that ports are open. If the engine is on one-fourth load the governor will close the ports when the piston has traveled one-fourth its stroke. If one-half load, the ports will remain open until the piston has traveled one-half its stroke. If on full load, the ports will remain open until the piston has made its entire suction stroke; should the full load be thrown off, the governor will act instantly, cutting down the port opening to one-sixteenth or one-eighth the piston travel, or should the full load be thrown on, the governor will instantly respond, holding ports open the entire stroke of piston.

The cylindrical valve is as shown in section, a cylinder having a bar across one end to attach the valve stem, having circular ports cut around it. By referring to Figs. 1 and 4, it can be observed that the governor pinion is provided with a wrist pin from which a reciprocating motion is imparted to the valve. The stroke of this always remains the same, hence, to get the automatic effect it will be necessary to rotate the pinion to change the position of wrist pin in relation to the crank.

Fig. 4 shows the Rites's governor with Burger's improvements, consisting of a pinion rotatable on the end of the crankshaft and carrying a wrist-pin to impart motion to the valve.

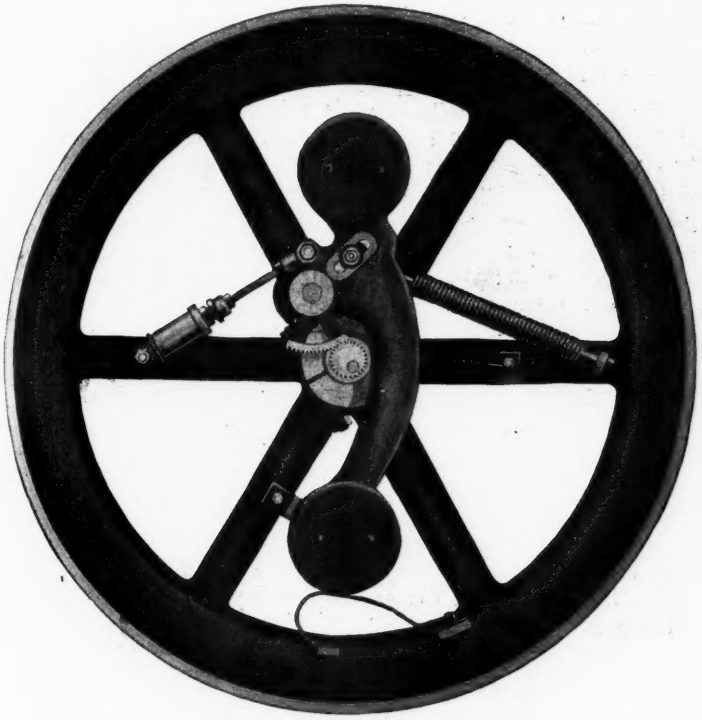


FIG. 4.—AUTOMATIC GOVERNOR FOR GAS ENGINE.

Fireproof Wire.

The Teter-Heany Developing Company, York, Pa., is manufacturing a new form of fireproof insulation. This consists of a fibrous web, so cemented together and so treated by heat and pressure that it forms a compact homogeneous mass and a chemical union with the copper wire. Contrary to the ordinary conditions under which insulation breaks down, further heating is stated to improve the dielectric qualities of this insulation. The accompanying illustration shows the method by which this insulation is applied: a^2 is the copper wire; a^1 is a chemical adhesive upon which the fibre is placed in a flocculent form; and A^1 shows the wire after being firmly compressed and the constituents united by heat. All this is done in one operation by the Heany apparatus, and the diameter shows a deviation of not more than 0.002 inch, when measured by a micrometer.

METHOD OF APPLYING FIREPROOF INSULATION.

The insulation is strong and flexible, withstanding bending and twisting strains without cracking, dripping or peeling off. It stands the severest weather changes, and is also acid and waterproof. The insulation contains nothing inflammable, and will not burn or carry flame. It is designed to be used for conductors for both line service and in the construction of electric machines.

The Rolling Stock of the Great Northern & City Railway, of London.

Work on the Great Northern & City Railway, of London, has been going on for about five years, and the road is now nearing completion. It is expected the road will be opened for public traffic within a few weeks. A large number of cars to be used on the railway have been delivered. The trains are to be made up of seven coaches, three of which, the two end and the middle coaches, are equipped with motors controlled on the multiple-unit system. The principal dimensions of the motor cars are: forty feet eight inches, length of body outside; forty-nine feet six inches, length over platform; width inside, eight feet nine inches; outside, nine feet four inches; height, eight feet four inches. The cars have a seating capacity for sixty passengers. The motor cars have fixed vestibules, and the trailers are without. The compartment containing the electric control apparatus is lined with sheet iron and asbestos. Each car is mounted on two trucks, the wheel base of each being six feet one inch. The distance between centres is thirty-four feet six inches, and the track gauge is four feet eight and one-half inches. They are fitted with Westinghouse quick-acting brake, and a hand brake.

Grand Rapids Automatic Telephone Exchange Put into Service.

[*Telegram to the Electrical Review.*]

The automatic telephone exchange of 5,000 stations was cut into service at Grand Rapids, Mich., on Saturday last—January 9—at 12.30 P. M. Seven minutes were consumed in making the change from the manual to the automatic system. The volume of calls coming in immediately after the change was four times greater than before. The Citizens' Telephone Company is now operating more automatic telephones than any other company in the world.

(Signed) AUTOMATIC ELECTRIC CO.

Chicago, January 12.

A New Multi-Voltage Electric Generator.

Mr. George H. Gibson, of Hyde Park, Mass., has invented a new multi-voltage electric generator, the patent for which has been assigned to the Westinghouse Electric and Manufacturing Company, of Pittsburg, Pa. The accompanying drawings show the simplest form of the in-

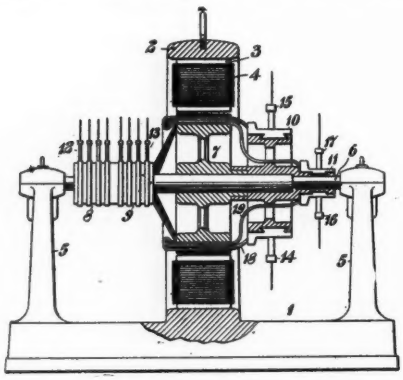


FIG. 1.—NEW MULTI-VOLTAGE ELECTRIC GENERATOR.

vention. Fig. 1 is shown partially in side elevation and partially in section, and Fig. 2 is a diagrammatic representation of the circuits of the machine. Referring to these illustrations, the machine comprises a suitable frame 1, having a field magnet yoke 2, provided with pole-pieces 3 and exciting coils 4, and also with bearing supports 5 for the shaft 6.

Mounted upon the shaft 6 and suitably keyed or otherwise fastened thereto are an armature spider 7; two sets of collector rings 8 and 9, and two commutator cylinders 10 and 11, a set of brushes 12 be-

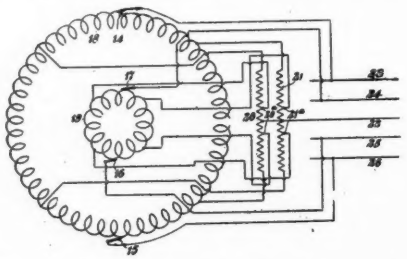


FIG. 2.—DIAGRAMMATIC REPRESENTATION OF CIRCUITS OF MULTI-VOLTAGE GENERATOR.

ing provided and suitably supported for making engagement with the respective rings of the set 8, and a similar set of brushes 13 being provided for making engagement with the collector rings of the set 9.

Commutator brushes 14 and 15 are also provided for engagement with the bars of the commutator cylinder 10, and similar brushes 16 and 17 are provided for engagement with the bars of the commutator cylinder 11.

Two armature windings 18 and 19, which may be located either in the same or in different slots in the armature core, are connected, respectively, to the commutator 10 and the commutator 11 and also to the sets of collector rings 8 and 9.

Two balancing coils 20 and 21 are provided, to the middle points of both of which is connected the neutral conductor 22 of the distributing circuit, the other conductors 23, 24, 25 and 26 of said circuit being respectively connected to the brushes 14, 17, 16, and 15 of the commutators 10 and 11.

The outer terminals of the balancing coils 20 and 21 may be respectively connected to the brushes 12 of the collector rings 8, and intermediate points 20*a* and 21*a* of the said balancing coils may be connected to the brushes 13 of the rings 9, the last-named points of connection of the balancing coils being so selected that the length of winding between each of these points and the middle point bears the same ratio to the length of winding between the outer terminal of the coil and the middle point that the length of the winding 19 bears to that of the winding 18.

The employment of collector rings and brushes in substantially the manner above indicated is obviously necessary in cases where the balancing coils are stationary; but if the coils are mounted upon the armature spider or its shaft, so as to rotate therewith, direct connections with the armature windings 18 and 19 may be made, as indicated in Fig. 2, and in view of the well-known character of the circuit connections first above mentioned the diagrammatic illustration in Fig. 2 may be regarded as indicative of each arrangement.

Two sets of balancing coils might be employed in such manner that each armature winding should have its own coils; but by employing the coils as indicated the apparatus is simplified and serves the same purpose.

It will be observed that each branch of each balancing coil is connected to points in the high-voltage and low-voltage armature windings that are always in phase. It will be also understood that instead of providing a single armature core with the two sets of coils separate cores may be utilized.

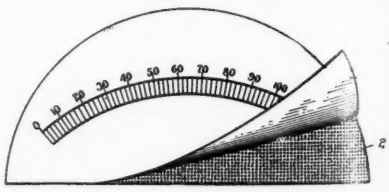
As here illustrated, the two armature windings have a ratio of one to four—that is, the low-voltage winding 19 has twelve coils and the high-voltage winding 18 has forty-eight coils, the former having six turns between brushes and the latter having twenty-four turns between brushes. The same ratio obtains between the number of turns in any balancing coil from the neutral point to the point of connection of the low-voltage armature winding and from the neutral point to the point of connection of the high-voltage armature winding, these lengths being here indicated as two and eight turns, respectively.

The object of this machine is to provide a plurality of different voltages for the operation of translating devices, and a method of deriving a considerable number of voltages of wide range in such a manner that the circuits corresponding to the different voltages may be utilized as desired, without disturbing the operation and regulation of the generator. The invention is primarily based upon the invention covered by patent No. 513,006, granted on January 16, 1894, to Michael von Dolivo-Dobrowolsky, in which a balancing or neutral conductor (between which and the main conductors the voltage is one-half that across the main conductors) is connected to the middle point of a balancing coil, the terminals of this coil being connected across the armature winding of the generator.

The provision of a proper ratio of voltages between the two coils allows a large variety of voltages to be secured from the external circuit. A number of small ratios may be employed, which will give different ranges of voltages, according to the ratios of the voltages to armature windings.

A Dial Plate for Electric Meters.

Mr. John Franklin Stevens, of Philadelphia, Pa., has designed and patented a new form of dial plate, which is especially durable and not likely to be affected by moisture. The dial plate is adapted



A NEW FORM OF DIAL PLATE.

for use in connection with electrical measuring instruments, but may be used with other forms of meters or indicating devices.

Referring to the accompanying illustration, the figure shows a view in perspective of this dial plate, with a cardboard section partly separated from the metal base of the dial plate. The essential feature of this invention is to so amalgamate a metal base and a cardboard scale plate that any liability of warping will be obviated. At the present time a metal plate between 0.020 and 0.025 inch thick

is employed, having about 400 perforations per square inch, this being approximately 0.025 inch in diameter. The plate may be made of brass, copper or tin, or of any suitable material. The cementing material employed may be shellac or any other substance found suitable to unite the cardboard with the metal. The cement should be a slow-drying cement, as it is frequently necessary to adjust the position of the scale card upon its metal backing, in order to make the pointer of the instrument fall within the space allotted to it within the cardboard.

Modern Developments in Rotary Converters.

The accompanying illustrations show the most modern development in rotary converters, Fig. 1 being the commutator end and Fig. 2 showing the collector ring end. Five of these rotaries were designed and built by the Bullock Electric Manufacturing Company, of Cincinnati, Ohio, for the Scioto Valley Pool, whose road has been exceptionally well designed both in generator as well as rotary substation equipment. These rotaries are of 500-kilowatt capacity, at 500 revolutions per minute, operating on twenty-five-cycle circuits, and deliver direct current at 600 volts.

In both the electrical and mechanical design of these rotaries the Bullock company has embodied several novel features. The field yoke is of cast iron, being made in two parts, bolted together by fillister-head cap-screws, countersunk in the yoke, which is covered by the name-plate and presents an extremely neat appearance. The poles are of cast steel, bolted to the yoke so that they can be easily removed without disturbing the armature. These cast-steel poles prevent hunting, which is a common fault with this type of machinery. The pole-tips are so proportioned as to evenly distribute the magnetic flux over a large number of armature teeth which greatly reduces the iron and heating losses in that region and also improves commutation. The fields are shunt wound.

Particular attention has been given to the electrical design of the rotary. The armature windings are carefully subdivided and considerable ingenuity exercised in the arrangement of the coils over the surface of the armature to reduce the heating to a minimum and produce good commutation. The commutator contains a large number of segments and has a liberal bearing surface for the brushes.

The collector rings on the alternating-current end are also made of copper, having large air-spaces between each ring, affording ample insulation. These rings also have a large bearing surface sufficient for two brushes. The brush-holders for the alternating-current end are the tangential type, using gauze-copper brushes. The brush-holders on the direct-current end are the standard Bullock reaction type with carbon brushes. They are mounted on heavy cast-copper studs, supported by a latticed brush yoke.

FIG. 1.—COMMUTATOR END, 500-KILOWATT ROTARY CONVERTER.

Rotary converters are usually intended for transforming alternating current into direct current or *vice versa,* and therefore the shaft and bearings are designed primarily to carry the armature and not to transmit or receive the rated capacity of mechanical power. These rotaries, however, are built exceptionally substantial and have large bearings to ensure cool running. This also eliminates to a great extent the troubles arising from faulty alignment of bearings and consequent increased pressure, due to careless erection.

Careful attention has been given to the ventilation of the armature, ventilating ducts being placed at frequent intervals throughout the armature core. This core is built up on a cast-iron spider, which is so cored as to allow air to circulate through the hub and also securing the blower effect due to the revolving

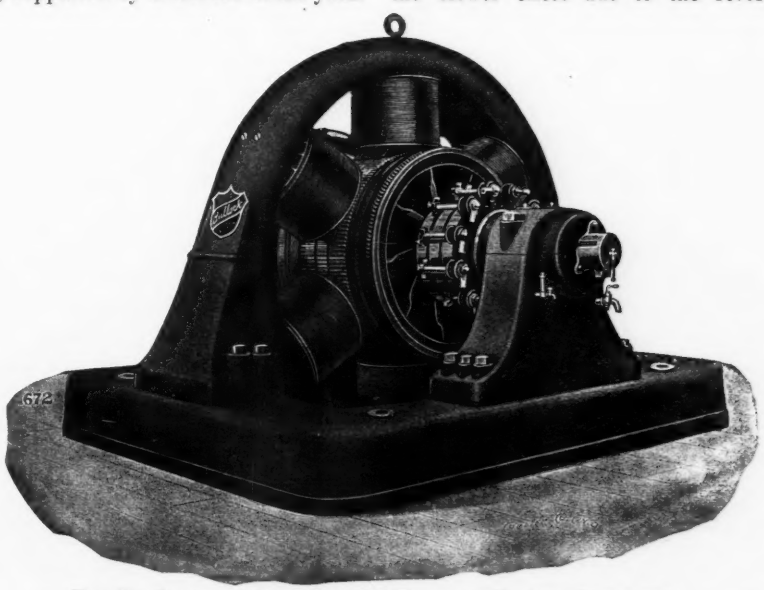


FIG. 2.—COLLECTOR-RING END, 500-KILOWATT ROTARY CONVERTER.

spokes. These machines are capable of withstanding heavy overloads for short periods, which is so important in rotaries.

This same type of rotary has recently been installed in another plant, to be used as a double commutator machine; later it will be used as an inverted rotary and finally as a rotary converter.

Portable Car Telephones.

A portable telephone instrument for use in despatching, or for other purposes on an electric car, must necessarily be able to withstand rough usage. Telephone manufacturing companies have apparently, in some cases, failed to provide amply for this contingency. The Stromberg-Carlson Telephone Manufacturing Company, Chicago, Ill., has recently designed a new portable car telephone which is of heavy construction so as to especially adapt it for use in interurban cars. Convenience of operation and conditions under which it will be used have also been taken into account in its construction. Fig. 1 shows the instrument open, and Fig. 2 shows the portable part or instrument proper removed, as would be necessary if it were to be used away from the car or if an exchange of instruments were to be made. The top box contains the telephone transmitter, magneto for calling and transmitter battery. The bottom box contains a reel of flexible cord. When the upper or telephone box is in place, it is connected to the cord on the reel in the lower box through contact plates on top of the reel box, which connects with buttons on the bottom of the telephone box. The object of the reel of cord is to enable connection to be made with plug receptacles on the pole near the car. The cord terminates in a plug similar to the plugs used in an exchange telephone switchboard. This plug, however, is much larger and heavier. There is a guide for the cord as it is wound on to the reel, and a crank on the outside of the reel box for winding up the cord. The receiver is of the watch-case type, and when not in use fits into a substantial receptacle, which operates like the usual receiver hook switch, to cut out the transmitter when the instrument is not in use. The portable part of the instrument or telephone box has a plug and short cord attached to it, for use when the telephone is used on the line away from the car. Fig. 3 shows the plug receptacle containing the jack, which is placed at the pole, and through which connection is made to the line.

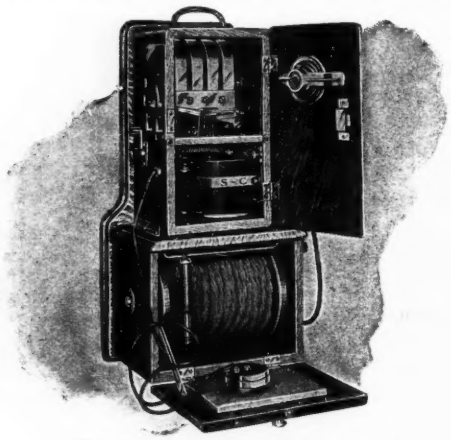


FIG. 1.—TELEPHONE, OPEN.

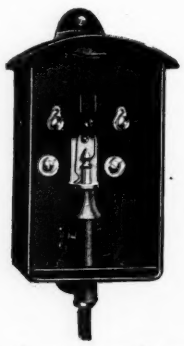


FIG. 3.—DESPATCHING PLUG BOX.

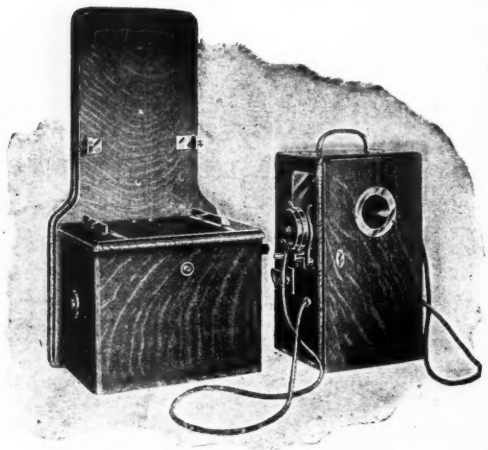


FIG. 2.—PORTABLE PART OR INSTRUMENT PROPER REMOVED.

The Northwestern Electrical Association's Convention.

The twelfth annual convention of the Northwestern Electrical Association will be held at the Hotel Pfister, Milwaukee, Wis., Wednesday, Thursday and Friday, January 20, 21 and 22, 1904. The following programme has been announced:

Wednesday Morning, 11.30—Roll call. Reading of minutes. President's address. Secretary and treasurer's report.

Wednesday Afternoon Session—Appointment of nominating and membership committees. Applications for membership. Reports of all committees except nominating. Miscellaneous business. The following papers will then be taken up: "Storage Batteries for Central Station Work," J. H. S. Waring. "Peculiarities of Magnets," Richard Varley. "Rectifiers," W. Scheidel.

In the evening a theatre party will be held.

Thursday Morning Session—Paper on "Double-Current Generators in Their Connection with Double-Current Supply," W. L. Waters. "Central Station Heating," W. H. Schott. "Standard Practice in the Use of Alternating-Current Electrical Apparatus," J. J. Gibson.

Thursday Afternoon Session—Report of nominating committee and election of officers. Paper on "Steam Turbines," James Lyman. One on "Rectifiers," by Professor C. F. Burgess. Illustrated lecture on radium, Professor R. A. Milliken.

On Thursday evening the annual banquet will be held.

On Friday morning unfinished business will be taken up.

The Automobile Show to Be Held at Madison Square Garden, New York City, N. Y., January 16 to 23, 1904.

The New York Automobile Show will open at Madison Square Garden, and continue there from Saturday, January 16, to Saturday, January 23, 1904. More than 185 firms have been accommodated in the distribution of space, and thirty or forty have had to go unprovided for lack of space. The exhibitors seem to have entered into a competition in the direction of decorating their respective booths, for they have made distinctive efforts in the line of arranging their stands to attract attention. More than 50,000 electric lights will be used for decoration and illumination.

Some of the many exhibitors are: Baker Motor Vehicle Company, E. W. Bliss Company, Buffalo Electric Carriage Company, Dayton Electrical Manufacturing Company, Detroit Motor Works, Diamond Rubber Company, R. E. Dietz Company, Dow Portable Electric Company, Electric Contract Company, Electric Vehicle Company, Federal Manufacturing Company, Fisher Motor Vehicle Company, Emil Grossman, General Electric Company, India Rubber Company, F. A. La Roche & Company, National Carbon Company, the George N. Pierce Company, the Rainier Company, Shelby Steel Tube Company, Studebaker Brothers Manufacturing Company, Varley Duplex Magnet Company, the Vehicle Equipment Company, and White Sewing Machine Company.

There will be exhibited power-driven machines for pleasure and for business, from the smallest to the largest size, and accessories from spark plugs to sealskin coats. The exhibitors will constitute both American and foreign manufactures. On the whole, it is anticipated that this will be the greatest automobile show ever held. The affair is held under the auspices of the Automobile Club of America, the National Association of Automobile Manufacturers, and the Madison Square Garden Company, with Mr. Frank W. Sanger as manager. The show will continue one week, from 10 A. M. until 11 P. M. daily.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

WIRELESS TELEGRAPH COMBINATION—At the annual meeting of the International Wireless Telegraph Company, held at Camden, N. J., January 6, a resolution to consolidate with the American De Forest Wireless Telegraph Company was adopted. The Greater New York Security Company will finance the consolidation.

MORTGAGE FOR $5,000,000—A mortgage executed by the Hudson River Electric Power Company, of Glens Falls, to the Knickerbocker Trust Company, of New York city, for $5,000,000, has been recorded in the Saratoga county clerk's office. The mortgage guarantees 5,000 $1,000 five per cent gold coupon bonds, payable in forty years, and is based on the company's dam at Speir's Falls, real estate in Saratoga and Warren counties, and dynamos and franchises in the towns of Moreau and Queensbury. The money is to be used in constructing a dam at Conklingsville, to make a storage reservoir in the Sacondaga river valley, for which land and water rights have been purchased.

WATER POWER AND LIGHTING SYSTEM FOR MEXICAN CITY—It is announced that a contract has been awarded for supplying Matehuela, a city of some 15,000 inhabitants, in the state of San Luis Potosi, with electric light and power, and for establishing a system of waterworks. The plans embrace the construction of four electric generating stations, which are to obtain their initial power from water which is to be piped from large natural springs situated on the top of a mountain at an altitude of 1,000 feet above the city, and at a distance of about twenty-two miles. The water will be piped from these springs to the power station, and then conveyed to Matehuela for the purpose of supplying the mains of the proposed waterworks system.

THE USE OF ELECTRICITY IN A MODERN BUILDING IN NEW YORK CITY—The plans for the electrical equipment of the Times Building, which is now being erected in New York city, are the most complete of any similar institution in the world. The electrical service will be supplied by the New York Edison Company, as a six-year contract has been closed, under the conditions that there will be independent connections with three supply stations of the Edison company. This outside electrical supply will furnish power for 109 motors, rated at 900 horse-power. Current for lighting for 4,000 incandescent lamps, fifteen arc lights, one searchlight, sign lamps, bulletin lamps, Cooper Hewitt lamps, and for many novelties, will be needed, the aggregate current amounting to more than 400,000 kilowatts per year.

CHICAGO TELEPHONE'S YEAR—During the year just closed the growth of the Chicago Telephone Company's list of exchanges has far exceeded that for all preceding years in the history of the company. An outlay of nearly $2,000,000 has been necessary to start this extension of service. One year ago the company had in operation 60,395 telephone stations. During the year more than 15,000 telephones have been added, giving a total number of telephones operated by the company in the city of Chicago of 76,000. The suburban districts show a condition of great prosperity, the total having reached the 25,000 mark, making the number of telephones now operated by the company over 100,000. The growth this year in the suburban and country districts has been 9,366, as against 8,738 in 1902. During the present year the company has expended in improvements for its suburban territory not less than $400,000. The territory operated by the Chicago company includes the counties of Cook, Will, Kane, DuPage, Grundy and Lake in Illinois, and Lake and Porter counties in Indiana.

CONNECTING LINK BETWEEN CLEVELAND, OHIO, AND BUFFALO, N. Y.—Trolley connection from Cleveland east to Buffalo will be established early next summer, when the Buffalo, Dunkirk & Western Traction Company completes its lines from Dunkirk to Buffalo. Nearly all of the grading is done and most of the poles are set, and the tracks will be put in place early in the summer. The Buffalo, Dunkirk & Western Railroad is a property owned by Luther Allen, J. W. Holcomb and other Cleveland business men. It runs from Buffalo to Dunkirk and Westfield, touching many prosperous cities between, and reaching a densely populated territory. At Westfield it will connect to the west with the Lake Erie Traction Company, owning a line through to Erie and another to Conneaut. At Conneaut it will connect with the Pennsylvania & Ohio to Ashtabula, and from there to Painesville with the Cleveland, Painesville & Ashtabula. From this point the Cleveland, Painesville & Eastern Railroad furnishes the connection to Cleveland. No arrangements have been made for through connections, but time schedules will be arranged so that close connections may be made at all points.

ALBANY-BOSTON TROLLEY SYSTEM—Electric railway communication between Albany, N. Y., and Boston, Mass., will soon be established, if the projected new trolley line in Worcester, Mass., is built. The Western Massachusetts Street Railway Company, which has already laid out its route from Lee to Westfield, where it will make connection with the Woronoco Street Railway Company, has surveyors at work on a route for a line from Stockbridge to the state line. It is reported that within a short time announcement will be made in Hudson, N. Y., of the organization of a company in that city to meet the Western Massachusetts company at the state line. The Western Massachusetts company's project is to build along the Westfield river to Chester, and then to strike directly west to East Lee, Mass., connecting with the Berkshire Street Railway Company at that place. From Stockbridge to the state line this company will also build, using the tracks of the Berkshire Street Railway Company from Lee to Stockbridge. The route from Stockbridge will be over the once well-known Lee & Hudson Railroad, a line that was laid out thirty years ago and the roadbed graded, but which was never built. The line will pass from Stockbridge over the Hudson & Lee route to West Stockbridge, and on to the state line. From there it will go directly west to Chatham; then south to Ghent and Philmont, touching Claverack and Mellenville, with its western terminus in Hudson, where connection will be made to Albany.

TELEPHONE AND TELEGRAPH.

ITHACA, N. Y.—The new Barrington & Wayne telephone line has been connected with the central office at Dundee.

UNADILLA, N. Y.—The Riverside Telephone Company has been granted a franchise by the board of trustees of the village.

WINCHESTER, VA.—A telephone line is being extended from Bloomery, W. Va., *via* Glengary and Shockeysville, to Martinsburg, W. Va.

WATKINS, N. Y.—The Empire State Telephone Company is now placing its wires underground in Canandaigua, this action being required by the village authorities.

BOYDS, MD.—The citizens of Kensington are trying to have a home telephone system established in their town, and have received permission from the mayor to string wires. The system will take in near-by villages.

RICHFIELD SPRINGS, N. Y.—The Earlville Telephone Company will extend its line toward Waterville, and the Waterville line will be extended to meet it. When connected it will afford a complete circuit to Utica.

PHILADELPHIA, PA.—The Bell Telephone Company has arranged for extensive additions and alterations to its building at Seventeenth and Filbert streets. New floors will be put in and interior changes made. The work will cost about $18,500.

BUFFALO, N. Y.—The Chautauqua Telephone and Telegraph Company, which was organized for the purpose of connecting and extending the independent telephone lines in western New York, has elected Thaddeus S. Lane, president; George W. Appleby, vice-president; Frank H. Matt, secretary, and B. D. Phillips, treasurer.

ELECTRIC RAILWAYS.

SUMTER, S. C.—The city council has granted a street railway franchise to D. A. Minor, C. W. Wheeler, J. M. Lawrence and L. D. Jennings.

ST. JOHNS, MICH.—The village council has granted a franchise to E. M. Hopkins for the proposed Ionia & Owosso electric railway through St. Johns.

HILLSBORO, ILL.—The city council has granted Isaac Hill a franchise to construct and operate an electric street railroad in this city, the work to be begun in one year and completed in two years. If the work is done the franchise will last twenty years.

SYRACUSE, N. Y.—It is reported that negotiations are pending by which the Syracuse Rapid Transit Company will buy the Syracuse, Lakeside & Baldwinsville Railway, which recently went into the hands of a receiver. If this is done a trolley line will be built to Oswego.

MOUNT HOLLY, N. J.—The work on the construction of the trolley line through this place to connect the lines running from Moorestown and Burlington has been commenced by the People's Traction Company. There is every indication that the road will be in operation by March 1.

BURLINGTON, N. J.—Plans are being perfected by the Camden & Trenton Railway Company for improving its road between Trenton and West Palmyra. Several sharp curves will be done away with, electric signals will be installed and the line will be equipped with a private telephone system.

LOUISVILLE, KY.—The Madisonville Traction Company has amended its articles of incorporation so as to allow it to construct a branch line from Madisonville through Earlington to Nortonville, a distance of twelve miles. Joseph M. Huffaker is president of the company and all its officers live in this city.

BOSTON, MASS.—The Consolidated Railroad Company is planning for a new suburban road into Boston, which will tap Newton, Dedham and Roxbury. The engineers of the company are now making surveys of the various routes. This branch will be the first through connection with the Woonsocket district.

SOUTH BEND, IND.—It is announced that the Chicago & Indiana Air Line Railway Company will begin construction of its proposed electric railway from South Bend to Michigan City, Ind., as soon as possible. Building, it is stated, will begin at the South Bend end and be pushed toward Michigan City. A portion of the grading was done last summer.

JACKSON, MISS.—A charter has been secured by citizens of Magnolia and Summit for an electric railroad between these points, and efforts will be shortly put forth to secure the necessary amount of capital to construct the line. It is believed by capitalists who have investigated the matter that the line would be a paying investment, as it would connect several of the most prosperous towns in Pike County.

SENECA FALLS, N. Y.—Active preliminary work for the electric road planned between Seneca Falls and Ithaca has commenced. Aaron C. Heddon, of the latter place, has been authorized to obtain subscriptions and rights of way from interested parties, his territory being from Ithaca to Lodi. A temporary organization named the Ithaca, Trumansburg & Seneca Falls Transit Company has been effected, with Ossian G. Noble, of Trumansburg, as president.

ATLANTA, GA.—A charter has been granted the Georgia Traction Company to build, maintain and operate an electric car line from Carnesville, Franklin County, through Madison County to Athens, Clarke County, a distance of thirty-three miles. The new road is capitalized at $500,000. The incorporators of the line are: E. H. VanWay and W. F. Brown, of Toledo, Ohio; J. R. Dorten, S. M. Ayers, J. R. Hall, R. H. Burrus, J. C. McCarter, B. B. Adderhold, W. R. Little, J. R. Tucker, of Carnesville.

SPOKANE, WASH.—It is stated that the electric road from Lewiston to Grangeville is now assured, and that construction work will begin in the spring. Part of the right of way has been secured, and active work is now going on to secure the balance necessary. It is expected that the line will be in operation in about a year from the time construction commences. As at present planned, the total length will be 100 miles. Power will be obtained from the Clearwater river, about four miles from Grangeville.

LA FAYETTE, IND.—The Fountain-Warren Traction Company, which was formed to construct an electric line from Covington, Ind., to Danville, Ind., and eventually extend the line to La Fayette, has made arrangements to begin construction work immediately. By the terms of the contract work will be begun on January 15 and be completed by October 1, 1904. A bridge will be built over the Wabash river. The company which will own the system is the same as was organized two years ago for the purpose of building the road.

NORWALK, OHIO—It is reported that there are now very bright prospects for the building by the Buckeye Traction Company of the electric railroad south from Norwalk, through North Fairfield, Steuben, Chicago Junction and Plymouth to Shelby, and thence to Mansfield. The franchise runs out next January. Philadelphia men say that they now stand ready to build the road at once if the franchise is renewed and the right of way is again secured. The latter is now being vigorously done, as the farmers are strongly in favor of the road.

ITHACA, N. Y.—According to the contract which has been awarded by the Ithaca-Cortland Traction Company, which was recently given a franchise by the State Railroad Commission, to build an electric railroad from Ithaca to Cortland, that section of the railway which will join Ithaca with the village of Dryden will be completed and ready for use on the fifteenth day of next May. As yet the contract for the portion of the road from Dryden to Cortland has not been awarded, but there is an assurance that it will be built before the end of the year.

SAN ANTONIO, TEX.—An electric road will be built from Fredericksburg to Waring, where it will connect with the San Antonio & Aransas Pass Railroad. The distance covered will be twenty-five miles and the cost of construction and equipment will be about $12,000 per mile. The road will be for passenger and freight, and sixty-pound steel rails will be laid. The right of way over the entire distance has been secured, and the abandoned roadbeds built by the citizens of Fredericksburg will be utilized. It is stated that the money for the road has been guaranteed.

ST. PAUL, MINN.—St. Paul is to have a short line electric road to lake Minnetonka, which will pass through Minneapolis. The petition for right of way of the Minnesota Power and Trolley Company has been filed with the Hennepin county commissioners, asking permission to use the former Great Northern grade from Hopkins to Excelsior. The interurban line will be built from St. Paul to Minneapolis, connecting with Hopkins. The track will be double, and will be of heavy steel rails with first-class equipment, it is announced. The electricity for the motive power will be generated at Elk river, where a large plant will be built to be operated by turbine wheel. Soundings are being made for a 20,000-horse-power dam to furnish the water power. Transforming points will be located at intervals to reduce the voltage.

WASHINGTON, IOWA—Notice of the incorporation of the Iowa City, Kalona & Washington Railway Company has been published as required by law, and the names of George G. Rodman, C. M. Keck, George W. Wagoner, George S. Carson, W. P. Coast, A. N. Alberson, U. G. Smith, C. S. Welch and S. W. Brookhart appear as incorporators. The time of commencement of the incorporation as shown by the notice is the nineteenth day of October, 1903, and the capital stock of the company is $50,000. This corporation purposes the building, constructing, equipping and maintaining and operating lines of railway, street railway, interurban railway, telegraph and telephone, in and from Iowa City, Johnson County, Iowa, to and in the city of Washington, Washington County, Iowa, and in and through any other counties, cities, towns or villages in the state of Iowa and in any other states or territories of the United States.

ELECTRIC LIGHTING.

READING, PA.—An electric light plant will be established at Bernville.

TERRELL, TEX.—It is stated that Crandall will erect an electric lighting plant.

SAN DIEGO, CAL.—A movement is on foot to establish an electric light plant at National City.

AUSTIN, TEX.—An electric light plant will be installed in the Brenham cotton mill, at Brenham, Tex.

SALEM, ILL.—The electric light committee of the city council has purchased a new 2,000-light dynamo.

COLUMBUS, OHIO—The Cadiz Electric Light and Power Company has increased its capital from $15,000 to $20,000.

NEGAUNEE, MICH.—At a special meeting of the common council it was decided to expend $15,000 in repairing the municipal electric light plant.

BARBERTON, OHIO—O. C. Barber and others have been granted a franchise to erect poles and string wires in connection with an electric light system.

LA CROSSE, WIS.—Albert F. Guenther, of Alma, has purchased the electric light plant in that city of Dr. Kempter, having assumed possession December 1.

LAPEER, MICH.—John Leslie, of Kentucky, has purchased the plant of the Lapeer Electric Light Company and has taken possession. He intends to enlarge it.

CAMBRIDGE, MASS.—The Cambridge Electric Light Company has petitioned the gas commissioners for authority to issue $100,000 additional stock for funding floating debt and additions to plant.

ALEXANDRIA CITY, ALA.—The Electric Light Company is enlarging its plant and increasing its equipment. A new dynamo is being installed and more lights and new wires are being placed all over the city.

PHILADELPHIA, PA.—In a three-year contract made with the local electric light company, the rates have been increased in Pottstown from $75 to $82.50 per year for arc lights and from $29 to $31.90 for incandescents.

YORK, PA.—Dallastown expects soon to be supplied with electric lights, operated by power obtained from the York County Traction Company. The traction company proposes to extend a special wire from York for this purpose.

NEW ALBANY, IND.—Work has been commenced on an electric plant for Charlestown, Clark County. The streets are to be lighted, and most of the business houses and many residences will use electricity for illumination and power.

NIAGARA FALLS, N. Y.—It is said that the Cataract Power Company's works at DeCew Falls can develop 65,000 electric horsepower, and that the company proposes to furnish Galt, Berlin and Waterloo with electric energy at $20 per horse-power per year.

MILLER, S. D.—The city council has awarded to Stephen Pauly a twenty-year franchise for the construction and operation of an electric light plant. The city reserved the right to purchase the plant after ten years if it is deemed advisable at that time to do so.

FRANKLIN, TENN.—A franchise for an electric light plant has been granted to J. S. Denton, representing Messrs. Whitson & Bell of Nashville, for a plant here. It is the purpose of the company to bid for the city lighting and to do a general business in that field.

DALLAS, TEX.—The service of the Oak Cliff Water Supply and Electric Light Company, it is stated, will be improved by the installation of a new 150-horse-power high-pressure boiler in place of the two sixty-horse-power low-pressure boilers that have been in service.

MUNCIE, IND.—The Albany Light and Power Company's plant, which supplies fuel and electric light to the town of Albany, was almost completely destroyed by a gas explosion recently. The loss is covered by insurance, and, it is said, the plant will be rebuilt at once.

PALMYRA, MO.—The Palmyra Light and Water Company, owned by B. F. Hobart, has been sold to W. E. McCully, of Macon. At a recent election the city voted down a proposition to buy the plant for $25,500, and it is presumed these are about the figures paid by Mr. McCully.

NEWARK, N. J.—New Providence borough has entered into a contract for street lighting with the Essex-Union Water and Light Company. The contract is to be for five years, at the expiration of which the borough has the privilege of purchasing the part of the plant in the borough.

MADISON, WIS.—Articles of incorporation have been filed by the Abbotsford Electric Light and Telephone Company, which purposes to operate a telephone system and supply electric power for lighting purposes. The company is capitalized at $25,000, and the incorporators are A. J. Young, C. G. Shilling and G. H. Shilling.

CLINTON, N. Y.—It is generally understood that the Oriskany Valley Electric Company and the Clinton Electric Company have consolidated. The former company was organized a short time ago, and is composed of Thomas F. McBride, of this place, W. C. McAdam, of Utica, and George I. Hovey, of Deansboro. The new combination has control of several excellent water powers on the Oriskany creek, besides the present site of the electric plant.

KALAMAZOO, MICH.—It is announced that the Kalamazoo Valley Electric Company will soon begin the construction of two more dams and power-houses, one at Ceresco and one on a second site near Plainwell. This will mean an additional expenditure of several hundred thousands of dollars and the addition of 6,000 horse-power to the present facilities. At present the company has dams near Allegan, Otsego and Plainwell, and power-houses in Battle Creek and Kalamazoo, with about 11,000 horse-power. The investment amounts to three-quarters of a million.

LIVINGSTON, MONT.—The Livingston Electric Light Company announces that it has concluded arrangements whereby it will be able to furnish private consumers with light within thirty or forty days. It has made arrangements for a temporary plant and expects to have it ready for operation within the time mentioned. The company will put in an entirely new and greatly enlarged plant next summer. The new plant will be more than double the capacity of the one recently destroyed by fire, and will be run so as to furnish light and power night and day. The present water power will be doubled and a new wheel will be added.

DENVER, COL.—Articles of incorporation have been filed for the Canon Power Company, capitalized at $500,000. It is the purpose of the corporation to build a pipe line, flumes and conduits, from Bear creek, a distance of four and six-tenths miles, to the site of a power plant which will be erected. The water will be used for developing electrical power for various purposes, and the pipe line will have a carrying capacity of thirty-five cubic feet of water per second. Electric light will be supplied to Morrison, Golden, Fort Logan, Littleton, Englewood and Denver. The three directors are Albert B. Sandford, Arthur K. Smith and George J. Bucher.

LIVINGSTON, MONT.—A number of Livingston and Fridley business men interested in the mines of the Emigrant district have decided to organize a joint stock company for the purpose of furnishing light and power for the operation of the properties and for the lighting of the town of Fridley, situated about twenty-five miles south of Livingston. The company will be capitalized at $50,000, more than half of which has already been subscribed. The power will be obtained from Emigrant creek, and the installation of the plant will be commenced within a few weeks. It is believed that the organization will be known as the Chico Light and Power Company.

REDLAND, CAL.—John B. Miller, president of the Edison Electric Company, states that the company intends to build a branch power line in the vicinity of Santa Barbara from the 60,000-volt transmission line which will connect with the 28,000-horse-power plant now being built at the mouth of Kern river with Los Angeles. A 1,000-horse-power plant on Lytle creek will be completed some time in February or March, 1904. Another of 2,000-horse-power is to be built on the Santa Ana river below the plant already built there. This will be completed some time in the summer, and both plants will be connected with the main transmission line running from Santa Ana river and Mill creek to Los Angeles. These plants represent an expenditure of $350,000.

NEW INCORPORATIONS.

TOPEKA, KAN.—Paxico Telephone Company. $2,100.

RICHMOND, VA.—Laurel Fork Telephone Company. $5,000.

TOPEKA, KAN.—Belleville Telephone Company. $35,000.

WORTHINGTON, IND.—The Greene County Telephone Company. $10,000.

KEWANEE, ILL.—Henry County Telephone Company. Increased from $2,500 to $15,000.

READSTOWN, WIS.—Readstown Telephone Company. $5,000. Incorporators: F. M. Groves, G. W. Henika and C. W. Reeve.

SPRINGFIELD, ILL.—Flanagan Telephone Company. $800. Incorporators: H. F. Mette, J. H. Linneman and D. Whalen.

BLOOMFIELD, IND.—The Green County Telephone Company. $10,000. Directors: Z. P. East, S. A. Dauhoff and H. W. Cooper.

INDIANAPOLIS, IND.—The Starke County Telephone Company. $5,000. Directors: W. Schweitzer, F. J. Weinkauf and H. A. Smith.

DENVER, COL.—The Washington County Telephone Company. $5,000. Directors: H. W. Twombly, C. D. Pickett and W. H. Spere, of Akron, Ohio.

DES MOINES, IOWA—Salt Lake & Bristol Telephone Company. $5,000. President, O. T. Groe; treasurer, A. T. Groe; vice-president, Otavius T. Groe.

JEFFERSON CITY, MO.—The Laplata & Western Telephone Company. $1,500. Incorporators: J. A. Dudly, D. O. Seaman, R. B. Enyant and others.

NELSONVILLE, OHIO—The York Telephone Company. $1,000. Incorporators: M. S. Wollett, J. W. Bennett, E. R. White, J. M. Bennett and J. G. Filley.

ALBANY, N. Y.—Traction Development and Securities Company. $200,000. Directors: S. B. Manning, Henry Oppenheimer and C. C. Marshall, of New York city.

MEMPHIS, TENN.—The Winona Water, Sewerage, Ice and Light Company. $175,000. Incorporators: Claude R. Kelson, Robert A. Allison, Arthur Flake and others.

AUSTIN, TEX.—Somerset & San Antonio Telephone Company. $3,000. Incorporators: W. R. Carruthers, A. G. Hunk, August F. Ernst, of Senior, Tex., and others.

ALBANY, N. Y.—Economic Electric Company. $200,000. Directors: I. L. Roberts and Edmund Tweedy, of New York city, and William Newcomb, of Tenafly, N. J.

DENVER, COL.—The Slusser Electric Light, Gas, Heat and Power Company. $10,000. Incorporators: M. M. Slusser, George D. Talbot, Amos C. Ludlow, all of Denver.

LOS ANGELES, CAL.—The Compton Water and Lighting Company. $25,000. Directors: E. E. Moore, C. I. Mason, W. S. Davis, J. V. Shepard and E. E. Elliott, all of Compton.

MILWAUKEE, WIS.—The Hammond Telephone Company. $5,000. Incorporators: F. B. Brown, B. E. Grinnell, C. A. Fuller, L. W. Keyes, P. C. Anderson and F. N. Burry.

TOLEDO, OHIO—The Empire Electric Company. $20,000. Incorporators: Frank F. Graves, Robert Tucker, William M. Godfrey, Charles E. Sumner and Charles Hartman.

RICHFIELD SPRINGS, N. Y.—Winfield Home Telephone Company. $5,000. Incorporators: Frederick C. Ward, Cooperstown; Willard Bullion, George Cany, Richfield Springs.

DENVER, COL.—Fruit Vale Mutual Telephone Company. $1,000. Directors: Lee Hall, Ray D. Garrison, John Jems, A. C. Wells, W. J. S. Henderson, D. L. Howard and F. D. Barney.

NEW YORK, N. Y.—The Brushton Electric Light Company, $5,500,000. Incorporators: Richard E. Hefferman, G. W. Gakey and Walter H. McCarthy, all of Brashers Falls, N. Y.

TALLAHASSEE, FLA.—Live Oak Telephone Company. $3,000. To construct and operate a telephone plant in the town of Live Oak. Directors: Cary A. Hardee, T. C. Smith and G. A. Lyon.

DENVER, COL.—Ute Land, Light, Power and Water Company. $50,000. Directors: T. C. Graden, R. E. Sloan, A. L. Pace, E. G. Bates, A. E. Mulqueen, W. H. McNichols, Thomas A. Rucker.

GUTHRIE, O. T.—The Ripley Automatic Telephone Company. $15,000. Incorporators: G. H. Foster, F. Shoup and J. P. Hinkle, of Ripley; R. A. Woodridge and J. W. Butcher, of Oklahoma City.

JEFFERSON CITY, MO.—Crab Orchard Telephone Company. $2,008. Incorporators: W. E. Hathaway, Hiram Burns, W. P. Heysey, E. E. Duffy, E. H. Cravens, M. A. Shipley, John O. Heaston, W. T. Roper and others.

AUSTIN, TEX.—Waxahachie Gas and Electric Company; $100,000; incorporators, Ose Goodwin, J. F. Strickland and M. B. Templeton, all of Waxahachie. Southern Traction Company; $25,000; incorporators, W. R. Lewis, Bay City; C. S. Hobbs, Hillsboro, and S. A. Robertson and I. L. Jacobs, Orange.

PERSONAL MENTION.

MR. N. B. RHOADS, who has been connected with the Savannah Electric Company, Savannah, Ga., has been appointed superintendent of transportation of the company.

MR. IRVING H. REYNOLDS, formerly with the Allis-Chalmers Company, has accepted a position with the William Tod Company, of Youngstown, Ohio, as consulting engineer.

MR. W. A. BIXBY, manager of the Decatur Traction and Light Company, Decatur, Ill., and other interests of the McKinley syndicate, has assumed the management of the syndicate at Quincy, Ill.

MR. LIONEL POST, formerly connected with the Alphons Custodis Chimney Construction Company, is now with Messrs. Bellman & Sanford, New York city, N. Y., general contractors for power plants.

MR. JAMES F. CUMMINGS, well known as an electrical engineer and contractor, and at present engaged on extensive underground construction in St. Petersburg, Russia, is in this country on a visit.

MR. T. J. RODERICK, superintendent of the Indianapolis & Shelbyville Traction Company, has resigned, and will be succeeded by Arthur A. Anderson, who will also be superintendent of the Indianapolis & Cincinnati Traction Company.

MR. PALMER WARDMAN, for several years master mechanic of the Cleveland, Painesville & Eastern Railway Company, has been appointed general superintendent of the Pennsylvania & Ohio Railway, with headquarters at Ashtabula, Ohio.

MESSRS. WATTS and COLE, consulting mechanical and electrical engineers, Pittsburg, Pa., have dissolved partnership by mutual consent. Mr. Cole will remain in business at the same address as a sales agent for lighting, power and mine supplies and equipment.

MR. FRED D. SAMPSON, who has held the position of engineer and superintendent for the past nine years for the Charlotte Electric Railway, Light and Power Company, has tendered his resignation to accept a position with the D. A. Tompkins Company, Charlotte, N. C., in the capacity of engineer.

MR. JAMES H. EDWARDS has been appointed assistant chief engineer of the American Bridge Company, in charge of building construction, with offices at 7 West Twenty-second street, New York city, and at Ambridge, Pa. Mr. C. G. Emil Larsson is appointed assistant chief engineer in charge of bridge construction, with offices at 100 Broadway, New York city, and at Ambridge, Pa.

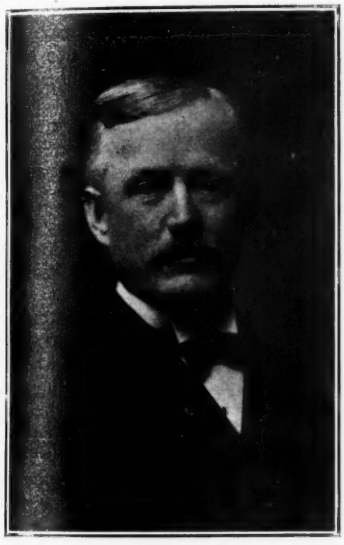
MR. A. B. SANDERS, who has for a number of years past been connected with the engineers' department of the American Telephone and Telegraph Company, in New York city, and later with the Electric Storage Battery Company, of Philadelphia, has connected himself with Mr. John B. Watson, Drexel Building, Philadelphia, Pa., taking charge of the electrical department.

MR. W. P. COSPER has accepted a position as salesman for the Garton-Daniels Company, Keokuk, Iowa. Mr. Cosper will give special attention to pushing the automotoneer, and will also look after lightning-arresters sales. Mr. Cosper has a large acquaintance among street railway companies, having for some time been western representative for the Consolidated Car Heating Company. Recently Mr. Cosper has been in the sales department of Fairbanks, Morse & Company, Chicago, Ill.

MR. WILLIAM E. COREY, president of the United States Steel Corporation, was presented by his associates in the operating de-

partment of the Carnegie Steel Company with a silver testimonial. The testimonial was made by Tiffany & Company, New York, and is an exact model in miniature of the famous forging press perfected by Mr. Corey and used for forging hot steel ingots into desirable shapes for armor-plate on battleships, structural iron and steel work for bridges, buildings, etc. It is made of sterling silver and mounted on a silver base, octagonal in form and purely structural in design. Eight beautiful Corinthian pillars form a part of the base. These columns admit of eight arched panels in which are vignettes in relief of notable subjects closely associated with the steel industry. The gift contains 535 ounces of sterling silver.

MR. N. S. BRADEN, formerly manager of the Westinghouse Electric and Manufacturing Company's district office at Cleveland, Ohio, has been appointed sales manager of the new Canadian Westinghouse Company, Limited, and assumed the duties of that office on January 1, 1904. Mr. Braden succeeds the late Thomas C. Frenyear, who died on December 10 of last year. Mr. Frenyear's office was at Toronto, but Mr. Braden will make his headquarters at Hamilton, Ontario. Mr. Braden was born at Indianapolis, Ind., thirty-four years ago, and finished his schooling in 1892, when he went with the Jenney Electric Motor Company, in Indianapolis. He remained with that company until 1899, when he joined the Cleveland district sales office of the Westinghouse company, as salesman, later becoming manager. He is known as one of the ablest and best-informed electrical salesmen in America.



MR. W. T. GENTRY.

VICE-PRESIDENT AND GENERAL MANAGER GENTRY, of the Southern Bell Telephone and Telegraph Company, was tendered a dinner at the Capitol City Club, Atlanta, Ga., on January 14, 1904, by the officials of the company in commemoration of his twenty-five years of service with the company. Mr. Gentry entered business life as a telegraph operator for the Southern Atlantic Telegraph Company in 1870, at Charlottsville, Va., serving the company later at Lynchburg and Richmond, Va., finally receiving the appointment of circuit manager with headquarters at Gordonsville, Va. The Southern Atlantic Company being absorbed in 1876 by the Western Union Telegraph Company, Mr. Gentry was transferred to Wilmington, N. C., at which place in 1879 he built the first telephone exchange, using the Edison patents and apparatus. After three years' service he was again transferred to the management of the Western Union office at Alexandria, Va., constructing at this place a telephone exchange in the interest of the Southern Bell Telephone and Telegraph Company and managing it in conjunction with the Western Union office until the latter part of 1883, when he accepted the appointment of manager of the same company's telephone exchange at Atlanta, Ga., and in 1891 was appointed assistant superintendent, which position he held until 1896, when he was promoted to the position of general superintendent of construction for the entire territory of the company, which included seven Southern states. In 1901 Mr. Gentry became general manager, and in 1903 was elected vice-president and general manager, which position he now holds, with headquarters at Atlanta. Mr. Gentry is a born diplomat, a man of much force of character, of vigorous understanding and boundless energy. Gifted with an amiable and lovable disposition, and imbued with loyalty to the interests he represents, and the friends he numbers by the thousands. The same qualities that made him, in spite of his empty sleeve and delicate health, an expert with the cue, the best rider, the best bird shot, the best baseball player, and the most all-round popular boy in school have brought him success and distinction in the business world.

ELECTRICAL SECURITIES.

In accordance with the general conclusion that there was considerable likelihood of a peaceful termination of the pending Far Eastern difficulty, stocks took on a better tone toward the close of the week Following the war scare and the rumors that an outbreak was imminent, there was considerable reduction in the taking of foreign government bonds, and the cotton and wheat markets were also visibly affected. The industrials, on the whole, however, have not been affected to any extent, and money conditions remain easy, with the probability of this condition being maintained for some time.

The passing of the common stock dividend by the United States Steel Corporation was not unexpected. This, however, has had the inevitable result of increasing the apathy of the public interest in the stock and bond market generally.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JANUARY 9.

New York:	*Closing.*
Brooklyn Rapid Transit	50¾
Consolidated Gas	192½
General Electric	173½
Kings County Electric	184
Manhattan Elevated	142⅞
Metropolitan Street Railway	121⅝
New York & New Jersey Telephone	150
Westinghouse Manufacturing Company	190

The New York & New Jersey Telephone Company announces the payment on January 15 of a dividend of 1½ per cent, and an extra dividend of 1 per cent.

Boston:	*Closing.*
American Telephone and Telegraph	125¼
Edison Electric Illuminating	230
Massachusetts Electric	75
New England Telephone	120
Western Telephone and Telegraph preferred	79

At the annual meeting of the Boston Elevated Railway Company officers and directors were elected.

Philadelphia:	*Closing.*
Electric Company of America	8⅜
Electric Storage Battery common	56
Electric Storage Battery preferred	56
Philadelphia Electric	5⅞
Union Traction	45⅞
United Gas Improvement	85½

Chicago:	*Closing.*
Chicago Telephone	120
Chicago Edison Light	147
Metropolitan Elevated preferred	54
National Carbon common	21½
National Carbon preferred	94
Union Traction common	7
Union Traction preferred	30

The Chicago Telephone annual meeting has been called for January 20, at 3 P. M. Books close for the meeting January 18 and reopen January 21. It is reported that the statement will show a handsome profit.

Traffic for December and for the year 1903 on the elevated railroads of the city broke all records, except in the case of South Side Elevated.

OBITUARY NOTICES.

MR. W. W. SPILES, president of the Shelby Electric Company, Shelby, Ohio, died on January 9, 1904. The funeral took place on January 13.

MR. FRANK HODGES CLARK, of Evanston, Ill., once private secretary to General Benjamin F. Butler, died at St. Luke's Hospital, Chicago, last week. For twenty-one years Mr. Clark was paymaster in the United States Navy. Since 1890 he was an official of the General Electric Company and the Westinghouse Electric and Manufacturing Company, at Washington, and was recently appointed receiver for the Helios-Upton Storage Battery Company.

GENERAL C. H. BARNEY died at his home in Hackensack on Sunday night, January 10, of spinal meningitis. He was sixty years of age. He served as adjutant-general of Rhode Island for five years. In Governor Van Zant's time he was a commissioner from New Jersey to the New Orleans Exposition. He served through the civil war as lieutenant in a northern regiment, and for several years was superintendent of the New York & New Jersey Telephone Company. He leaves a wife and three adult children.

INDUSTRIAL ITEMS.

THE CASE SCHOOL OF APPLIED SCIENCE, Cleveland, Ohio, has published its annual catalogue for 1903-1904.

EMIL GROSSMAN, New York city, N. Y., is sending out a catalogue of automobile accessories. The catalogue will be sent on request.

THE AMERICAN ELECTRIC HEATER COMPANY, Detroit, Mich., is sending out a unique paperweight in the form of a midget electric flatiron.

THE COLUMBIA INCANDESCENT LAMP COMPANY, St. Louis, Mo., is sending out a small pamphlet entitled "The Square Thing." This pamphlet will be sent on request.

THE GERMANIA ELECTRIC LAMP COMPANY, Harrison, N. J., has recently issued a leaflet containing prices of incandescent lamps which it manufactures. The leaflet will be sent on request.

THE GENERAL ELECTRIC COMPANY, incandescent lamp department, Harrison, N. J., is sending out a wall circular for use in ordering incandescent lamps. This circular will be sent on request.

THE STANDARD TRUCK COMPANY, Philadelphia, Pa., is sending out its catalogue illustrative and descriptive of the "Vickers'" self-loading hand truck and wagon. Catalogue will be sent on request.

THE ATWATER KENT MANUFACTURING WORKS, Philadelphia, Pa., is sending out a booklet in which is listed automatic volt-ammeters, voltmeters and ampere-meters. This catalogue will be sent on request.

THE BANNER ELECTRIC COMPANY, Youngstown, Ohio, is issuing a pretty souvenir in the form of an embossed lithograph, showing ears of corn promiscuously dumped out of a basket which is upset. This lithograph will be sent on request.

THE WICKES BROTHERS, New York city, N. Y., is sending out its monthly stock list for January, 1904, which contains a list of new and second-hand boilers, engines, pumps, generators, machinery, etc. The company will send this stock list on request.

THE MARSHALL-SANDERS COMPANY, Boston, Mass., reports some important orders from abroad for its well-known push-button switches. The new M-S sockets made by this company embody a number of new ideas which are said to be very interesting. A postal card request will bring a sample socket.

THE DEITZ DRILL AND MACHINERY COMPANY, Denver, Col., is sending out its catalogue No. 1, descriptive of the "Deitz electric rock drill." There is contained in this catalogue an especial invitation to call at 1,614 Blake street, Denver, Col., where a drill may be seen in operation. The company will be glad to send catalogue on request.

THE NEW ERA GAS ENGINE COMPANY, Dayton, Ohio, is mailing its new 1904 catalogue, illustrating and describing "New Era" and "Little Giant" gas and gasoline engines. The name of this company has recently been changed from the New Era Iron Works. The company is building a complete line of gas and gasoline engines, both as to styles and sizes.

THE AMERICAN STEEL AND WIRE COMPANY, New York, Chicago, Worcester, Denver and San Francisco, U. S. A., is sending out its catalogue which contains a list of the company's products such as steel plates and sheets, telegraph and telephone wires, turned shafting, standard wire nails, woven wire fencing, electrical wires and cables, etc. The company will be pleased to send catalogue on request.

THE ELECTRICAL APPLIANCE COMPANY, Chicago, Ill., is distributing a bulletin in which is enumerated "points" in connection with Adams-Bagnall arc lamps. Among the points enumerated are: 125,000 of these lamps in successful operation. No change of model in the past five years. Seventy-five per cent of the parts of these lamps are interchangeable, and no delay in getting parts at any time. The complete bulletin will be sent on request.

THE COMMERCIAL ELECTRIC COMPANY, Indianapolis, Ind., is sending out a valuable leaflet entitled "A Standard Light Plant." This leaflet contains interesting suggestions as to the vital parts of the dynamos, such as "the gearings," "the armatures," "the commutators," "the fields," etc. It also contains a list of complete equipment for a sixty-five-light plant, 100-light plant and a 160-light plant, with approximate prices. This leaflet will be sent on request.

THE WIRT ELECTRIC COMPANY, Philadelphia, Pa., is sending out its circular No. 305, which is illustrative and descriptive of rheostats for use in charging storage batteries. The company is also sending out circulars No. 308 and 309, which treats on dynamo field rheostats and the "Wirt" dynamo brush, respectively. Circular No. 308 contains an article describing the "Wirt" dynamo rheostat by C. Wirt, and 309 contains an article on "The Care of Commutators," and an abstract from a paper by F. J. Turner—"A Few Points in Relation to the Construction of Commutators." These circulars will be sent on request.

MR. E. STUTZ, 54 Front street, New York city, is the representative of the thermit process controlled by the Chemical and Tin Smelting Works of Th. Goldschmidt, Essen-Ruhr. Mr. Stütz announces that he is now in a position to supply thermit appliances, such as crucibles, etc., from stock in New York. Various pamphlets can be obtained from him, giving instructions for the use of the material in a concise and clear form, so that any intelligent mechanic can be made acquainted with the thermit welding process in its various branches. Mr. Stütz will probably lecture on aluminothermics before the Franklin Institute, Philadelphia, Pa., on January 20, and at the Massachusetts Institute of Technology, Boston, Mass., on February 28.

THE LAWRENCE-HALL ELECTRIC COMPANY, Cincinnati, Ohio, is establishing an elaborate card system to keep it informed about all sorts of electrical contrivances. This will be a good opportunity for any concern to correspond with the company that has not already done so. The Lawrence-Hall company will be pleased to have any concern inform it as regards any new electrical appliance that may be brought out. The company is also sending out a leaflet descriptive of the "electrotherm," which is an electrical substitute for the hot-water bottle. The "electrotherm" is composed of wires insulated and protected by asbestos woven into a light and flexible sheet or pad, which when connected to the ordinary incandescent lamp socket offers sufficient resistance to the current to produce a constant and uniform degree of heat.

THE DEAN ELECTRIC COMPANY has been incorporated under the laws of the state of Ohio for the manufacturing of telephone specialties. The company will erect a modern factory building adjacent to the main line of the Lake Shore Railroad, at Elyria, Ohio. The officers of the new company are Samuel B. Rawson, president; William W. Dean, vice-president and chief engineer; T. M. Brush, treasurer; A. E. Barker, secretary and general manager. These gentlemen, with Mr. I. H. Griswold, are the incorporators. Messrs. Rawson, Griswold and Brush are well known in the independent telephone field, and are the founders and builders of a large number of exchanges in the states of New York and Ohio, among which are Albany, Schenectady, Cohoes, Niagara Falls and Elyria. Mr. A. E. Barker has been in the independent telephone business for a number of years, being one of the engineers and builders of the Detroit and New Orleans exchanges. In addition to this experience, he has had several years work with the Kellogg Switchboard and Supply Company, Chicago, Ill., in an engineering capacity, and finally had entire charge of the sales end of the business, with the title of sales manager. Mr. Dean has been connected with the telephone business for about twenty years, and has been with the following companies: the Bell Telephone Company, of Missouri, at St. Louis; the Union Telefonica Company, Buenos Aires, South America; the American Bell Telephone Company, of Boston; the Western Electric Company, Chicago, and the Kellogg Switchboard and Supply Company, of the same city. The capital stock of the new company will be $300,000.